



**M.Sc.**

**BIOCHEMISTRY**

**Curriculum and Syllabus**

**(Based on Choice Based Credit System)**

**Effective from the Academic year**

**2018-2019**

**Department of Biochemistry**

**School of Life Sciences**

**M.Sc. BIOCHEMISTRY**  
**REGULATIONS**

**VELS INSTITUTE OF SCIENCE, TECHNOLOGY AND ADVANCED STUDIES**

**M.Sc. BIOCHEMISTRY**

**POST GRADUATE DEGREE COURSE**

**REGULATIONS**

**(Effective from the Academic Year 2018-19)**

**1. ELIGIBILITY FOR ADMISSION**

Candidates for admission to the first year of the post graduate degree course in M.Sc. Biochemistry shall be required to have a Bachelor's degree in Science of any recognized University with Biochemistry, Microbiology, Biotechnology, Chemistry and Life Sciences as their main subject.

**2. ELIGIBILITY FOR AWARD OF THE DEGREE**

A candidate shall be eligible for the award of the Degree only if he/ she has undergone the prescribed course of study in the University for a period of not less than two academic years, passed the examinations of all the four semesters prescribed earning 90 credits and fulfilled such conditions as have been prescribed therefore.

**3. DURATION OF THE PROGRAM**

The duration of the course is for two academic years consisting of four semesters.

- a) Each academic year shall be divided into two semesters. The first academic year shall comprise the first and second semesters, the second academic year the third and fourth semesters respectively.
- b) The odd semesters shall consist of the period from July to December of each year and the even semesters from January to June of each year. There shall be not less than 90 working days for each semester.

**4. ATTENDANCE**

Students coming late will not be given attendance. Attendance is recorded for each hour separately. One hour of absence for each session is considered as being absent for the entire session. No student is permitted to absent himself/herself without prior sanction of leave. If a

student absent himself/herself for a week without leave, his/her name will be removed from the rolls. He/She has to get permission for re-admission after furnishing valid reasons.

Students appearing for the university examinations must have a minimum of 75 % attendance, failing which they will not be permitted to write the examinations. However, the University may condone the attendance shortage of 10 % after collecting a condonation fee from the students who have secured 65 to 74 % of attendance.

## **5. COURSE OF STUDY**

The Main Subject of study for Masters Degree shall consist of the following.

[1] CORE COURSES consisting of Fundamental papers, Practicals, Project and Internship.

[2] ELECTIVE COURSES consisting of a) Discipline Specific Electives and (b) Generic Electives

[3] COURSE ON COMMUNICATION SKILLS

## **6. SCHEME OF EXAMINATION**

The University follows semester pattern with Credit Based Semester System (CBSS). The post graduate course is for four semesters. There shall be four examinations, the odd semester examinations at the middle of the academic year and even semester examinations at the end of the academic year.

The students have to earn minimum credits assigned by the Board of Studies to become eligible for the award of the degree. Students of post graduate courses are to undergo a course in communication skills during the first and second semesters, each carrying two credits.

For the students admitted from the academic year 2015-2016, the components of Continuous assessment and semester end examination marks are 40% and 60% respectively.

A passing minimum mark in continuous assessment is not necessary to get a pass. The statement of marks will be issued to the students on par with International Standard incorporating Weighted Average Marks (WAM) and Grade Point Average (GPA) for each semester.

Registration for exams - All candidates shall register their names for the first semester examinations and will be permitted to proceed up to final year irrespective of their failure in any of the semester examinations. The candidates should register for all the arrear subjects of earlier semesters along with the current semester subjects.

Practical examination -Practical examinations will be conducted at the end of the respective semesters.

### **Internship**

The students have to undergo an internship for a period of four to six weeks for which they earn two credits.

### **Project**

The course will have a project work in their final semester and the students have to earn the number of credits prescribed for by the Board of Studies.

### **7. REVALUATION OF ANSWER SCRIPTS**

Revaluation of answer scripts for the current semester is permissible. The students have to apply for revaluation in the prescribed format within 10 days from the date of publication of results along with prescribed fee.

### **8. SUPPLEMENTARY EXAMINATION**

A supplementary examination will be conducted during the month of July/August for Final semester students who have failed in one or two subjects so as to enable the students to qualify for the course to get their degree instead of waiting for another six months (i.e., till December) to appear for the failed subjects.

### **9. INTERNAL ASSESMENT:**

The revised break-up marks of continuous assessment as applicable to PG courses has been shown as below

<b>S.No.</b>	<b>Test Component</b>	<b>PG</b>
<b>1.</b>	Two C.A. class tests	<b>10 (2x5)</b>
<b>2.</b>	Assignment/Class Seminar	<b>05</b>
<b>3.</b>	Model Examinations	<b>05</b>
<b>4.</b>	Attendance	<b>05</b>
<b>5.</b>	Field visit/Internship etc - PG	<b>05</b>
<b>6</b>	Aptitude of the Student	<b>05</b>
<b>7.</b>	Student's assessment by the Faculty	<b>05</b>
<b>Total Marks</b>		<b>40</b>

## 10. DISTRIBUTION OF MARKS FOR ATTENDANCE

S.No.	Percentage of Attendance	Marks
1.	91 % to 100 %	05
2.	75 % to 90 %	04
3.	65 % to 74 %	03
4.	Less than 65 %	00

## 11. REQUIREMENTS FOR PROCEEDING TO SUBSEQUENT SEMESTER

Candidates shall register their names for the First Semester Examination after the admission in the PG Courses.

Candidates shall be permitted to proceed from the First Semester upto Final Semester irrespective of their failure in any of the Semester Examinations subject to the condition that the candidates should register for all the arrear subjects of earlier semesters along with current (subsequent) semester subjects.

Candidates shall be eligible to go to subsequent semester, only if they earn sufficient attendance as prescribed by the Board of Management from time to time, provided in case of a candidate earning less than 50% of attendance in any one of the semester due to any extraordinary circumstance such as medical grounds, such candidates who shall produce Medical Certificate issued by the Authorized Medical Attendant (AMA), duly certified by the Dean/Director & Head of the Department, shall be permitted to proceed to the next semester and to complete the Course of Study. Such candidates shall have to repeat the missed Semester by rejoining after completion of Final Semester of the Course, after paying the fee for the break of study as prescribed by the University from time to time.

## 12. PASSING MINIMUM

A candidate shall be declared to have passed in each paper/ practical of the Main Subject of Study wherever prescribed, if he/she secures not less than 50% of the marks prescribed for the examination. He/She shall be declared to have passed the whole examination, if he/she passes in all the papers and practical wherever prescribed / as per the scheme of examinations earning 90 credits.

### **13. RANKING**

Candidates who pass all the subjects as prescribed for the Course in the first appearance itself or those with a break in the First Appearance due to the reasons as furnished in the Regulations 7(iii) supra are only eligible for Classification / Distinction.

### **14. TRANSITORY PROVISION**

Candidates who have undergone the course of study prior to the academic year will be permitted to appear for the examinations under those Regulations for a period of two years i.e., up to and inclusive of April / May 2017 Examinations. Thereafter, they will be permitted to appear for the examination only under the regulations then in force.

## M.Sc BIOCHEMISTRY CURRICULUM

**Total Credits - 90**

CATEGORY	CODE	TITLE OF THE PAPER	Hours / Week			CREDITS
			L	T	P	
<b>SEMESTER I</b>						
CORE	15MBC001	Chemistry of Biomolecules	5	-	-	4
CORE	15MBC002	Advanced Instrumental Techniques	5	-	-	4
CORE	15MBC003	Practical I Biochemistry & Instrumentation Lab	-	-	10	3
DSE		Discipline Specific Elective 1	4	-	-	4
DSE		Discipline Specific Elective 2	4	-	-	4
GE		Generic Elective 1	2	-	-	2
		Total	<b>20</b>	-	10	<b>21</b>
<b>SEMESTER II</b>						
CORE	15MBC004	Enzymology	5	-	-	4
CORE	15MBC005	Intermediary metabolism	5	-	-	4
CORE	15MBC006	Practical II Biotechnology Lab	-	-	4	3
CORE	15MBC007	Practical III Microbiology Lab	-	-	4	3
DSE		Discipline Specific Elective 3	4	-	-	4
DSE		Discipline Specific Elective 4	4	-	-	4
GE		Generic Elective 2	2	-	-	2
GE		Generic Elective 3	2	-	-	2
		Total	<b>22</b>	-	<b>8</b>	<b>26</b>
<b>SEMESTER III</b>						



CORE	15MBC008	Genetics and Molecular Biology	5	-	-	4
CORE	15MBC009	Clinical biochemistry	5	-	-	4
CORE	15MBC010	Practical III Clinical Biochemistry Lab	-	-	10	3
DSE		Discipline Specific Elective 5	4	-	-	4
DSE		Discipline Specific Elective 6	4	-	-	4
GE		Generic Elective 4	2	-	-	2
CORE		Internship	-	-	-	2
		Total	<b>20</b>	-	<b>10</b>	<b>23</b>
<b>SEMESTER IV</b>						
CORE	15MBC011	Toxicology and Forensic Biochemistry	4	-	-	4
CORE	15MBC012	Project	26	-	-	16
		Total	<b>30</b>	-	-	<b>20</b>

**TOTAL CREDITS**

**90**

## **List of Electives**

### **List of Discipline Specific Electives**

1. 15MBC101 Human Physiology And Basics Of Anatomy
2. 15MBC102 Cell Biology
3. 15MBC103 Fundamentals Of Computers, Biostatistics And Research Methodology
4. 15MBC104 Phytochemistry, Pharmacognosy & Quality Control
5. 15MBC105 Microbiology And Immunology
6. 15MBC106 Biotechnology and IPR
7. 15MBC107 Modern Lifestyle Associated Diseases
8. 15MBC108 Neurobiology
9. 15MBC109 Endocrinology
10. 15MBC110 Plant Biochemistry
11. 15MBC111 Biochemical Toxicology
12. 15MBC112 Molecular Developmental Biology
13. 15MBC113 Nanotechnology
14. 15MBC114 Stem cell technology
15. 15MBC115 Cancer Biochemistry
16. 15MBC116 Biochemistry of cell signaling
17. 15MBC117 Environmental Science

### **List of Generic Electives**

1. 15MBC151 Communicative English I
2. 15MBC152 Communicative English II
3. 15MBC153 Bioinformatics
4. 15MBC154 Pathological Basis of Diseases
5. 15MBC155 Biomaterials
6. 15MBC156 Medicinal Botany

## **CORE COURSES**

**Course objectives**

The objective is to study about the structure and biological functions of macromolecules such as proteins, polysaccharides, lipids, and nucleic acids, as well as small molecules such as primary metabolites, secondary metabolites, and natural products.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Easily understand the basic concepts/functions of solutes, chemical bonding and organic compounds
- CO2: Describe the classification of biomolecules
- CO3: Describe the basic reaction types and mechanisms of bio molecules
- CO4: Understand the structures and functions of biomolecules
- CO5: Analyse and study the chemical and biochemical properties of bio molecules
- CO6: Understand relationships between biological molecules and human health
- CO7: Identify biomolecules structural differences and its properties
- CO8: Gain an understanding the basic principle of chemistry as well as biology
- CO9: Understand the scope of biological chemistry
- CO10: Easily understand the interrelationship of organic compounds and homeostasis in biological organisms

**Unit 1 Carbohydrates (12)**

Carbohydrates: Classification of Carbohydrates. Structure and functions of Monosaccharides, Disaccharides and Polysaccharides. Structure and biological importance of sugar derivatives, Glycosaminoglycans, Proteoglycans, Glycoproteins and Lipopolysaccharides.

**Unit 2 Proteins (12)**

Classification, structure and properties of amino acids and proteins. Structural organisation of proteins – Primary structure and its determination, Secondary and Super secondary structures, Tertiary and Quarternary Structure. Peptide Synthesis. Isolation and purification of proteins.

**Unit 3 Lipids (12)**

Lipids- Classification, structure and functions of fatty acids, alcohols and lipids. Physical and chemical properties of fatty acids. Structure and function of Eicosanoids, Lipoproteins-classes, transport and functions. Steroids.

**Unit 4 Nucleic acids (12)**

Structure of nucleosides, nucleotides. DNA double helical structure. A, B and Z forms of DNA. Triple and quadruple structure. DNA super coiling and linking number. Properties of DNA – buoyant density, viscosity, hypochromicity, denaturation, renaturation, Cot curve. Chemical synthesis of oligonucleotides. DNA sequencing. Major classes of RNA, their structure and biological role.

**Unit 5 Nanoparticles (12)**

Definition of a nanosystem, Basic concepts of nanoscience and technology. Time and length

scale in structures. Overview on nanomaterials. Protein nanoparticles. Biological nanostructures, Novel delivery routes using nanoparticles with special reference to drug delivery process.

**Total : 60 hours**

**Text Books**

1. J.L.Jain et al. Fundamentals of Biochemistry by S.Chand and Company 4th edition, 1994.
2. M.N.Chatterjea and Ranashinde Text book of Medical biochemistry Jaypee Brothers Medical Publisher (P) Ltd, 6<sup>th</sup> edition 2005.

**Reference Books**

1. Lippincott's illustrated biochemistry – Champe and Harvey; 6<sup>th</sup> edition 2007.
2. D.Voet and J.G. Voet, Biochemistry, John Wiley & Sons, USA 2004.
3. Albert L. Lehninger Principles of Biochemistry CBS Publishers & Distributors, New Delhi, 4th edition 2004.

**Course objectives**

Advanced instrumental techniques are used to understand the theoretical principles involved in Bioinstrumentation which may be used for the determination of nutrients, major ions and trace elements, biological samples together with the analytical techniques. Some of these techniques are particularly useful for the detailed analysis of recent methodologies used in the chemical analysis of biota as discussed in the chapter.

**Course outcomes**

**After the completion of this course, the student will be able to**

- CO1: Demonstrate broad knowledge in modern analytical instrumentation with deep knowledge in its core concepts and its applications.
- CO2: Understand the principle, Instrumentation of different types of Light microscopy and electron microscopy and its applications in various fields of research.
- CO3: Acquire knowledge about the basics and latest developments in the instrumentation techniques of Centrifugation, Electrophoresis (IEF, 2D PAGE) and Chromatography and their applications in various research fields.
- CO 4: Demonstrate skill to explain about principle, Bioinstrumentation and applications of latest spectroscopy techniques like Turbidometry, AAS, NMR, ESR and Nephelometry.
- CO5: Gain extensive exposure from basic to latest cytotechniques (FISH technology & Biochip technology).
- CO6: Learn about basic Radioactivity principles, measurement method and its biological applications.
- CO 7: Get exposed to latest technology of Biosensors and its wide range of applications ranging from clinical, environmental and agricultural field.
- CO8: Acquire cognitive, technical and creative skills which enables students to gain an established knowledge and practice concerning modern analytical instrumentation and measurement techniques.
- CO9: Understand the importance and applications of advanced biochemical instrumentation techniques in modern day research.
- CO10: Develop skill in carrying out research projects by employing the basic biochemical and molecular techniques.

**Unit 1 Microscopy and Cytotechniques****(12)**

Microscopy - Principles of Microscopy – bright and dark field, fluorescence, phase contrast, scanning and transmission electron microscopy.

Cytotechniques – tissue homogenization and Cell disruption, cell counting and sorting, cell culture techniques, preservation of cell and tissues. Biochip Technology.

**Unit 2 Radioactivity and Biosensors****(12)**

Pulse – Chase Techniques: Radioactive isotope and half life of isotope, nature of radioactivity. Detection and measurements - GM counter, Scintillation counter. Safety aspects. Biological applications: assessing the metabolic pathways, radio dating, radio immuno assay, isotope dilution technique, autoradiography.

Biosensors - Introduction to Biosensors: Concepts and applications. Biosensors for diabetes management. Noninvasive Biosensors in Clinical Analysis.

### **Unit 3 Centrifugation and Electrophoresis (12)**

Centrifugation: Basic Principles of Centrifugation. Instrumentation and applications of Preparative - Differential and Density Gradient Centrifugation, Analytical Ultracentrifugation – ultra centrifuge, applications.

Electrophoresis: Principles and Factors Affecting Electrophoresis. Principle, methodology and applications of PAGE, SDS-PAGE, IEF, 2D PAGE, Agarose Gel Electrophoresis.

### **Unit 4 Chromatography (12)**

Chromatography: Principles, Instrumentation and Applications of Paper Chromatography, TLC, Column Chromatography, LPLC, HPLC, Gel filtration Chromatography, Ion-Exchange Chromatography, Affinity Chromatography and GLC .

### **Unit 5 Spectroscopy (12)**

Spectroscopy: Basic Principles of Electromagnetic Radiation, Beer-Lambert's Law. Principle, instrumentation, operation and applications of UV-Visible, IR, Raman Spectrophotometry, Spectrofluorimetry, Flame Photometry, AAS, NMR, ESR, X-Ray Diffraction, , Turbidometry and Nephelometry, Mass spectrometry, MALDI-TOF .

**Total : 60 hours**

### **Text Books**

1. Keith Wilson and John Walker, Principles and techniques of Practical Biochemistry, 2010, Seventh edition, Cambridge University Press
2. Asokan P, Analytical biochemistry Biochemistry, 2009, Chinna publication.

### **Reference Books**

1. Holme. D. J. and Peck. H., Longman Analytical Biochemistry, 1998, 3<sup>rd</sup> edition.
2. Chatwal, G & Anand, S, Instrumental methods of chemical analysis, 2005, Himalaya Publishing House
3. S. K. Sawhney & Randhir Singh, Introductory Practical Biochemistry, 2014, Narosa Publications House

## **15MBC003 PRACTICALS I BIOCHEMISTRY AND INSTRUMENTATION LAB 0 0 8 3**

### **Course objectives**

The course aims to develop skills of performing basic biochemical tests important in clinical investigations, to develop familiarity with biochemical laboratory techniques, and to introduce students to various practical aspects of enzymology and their correlation in disease conditions.

### **Course outcomes**

**After the completion of this course, the student will be able to**

- CO1: Learn how to standardise various biomolecules.
- CO2: Track various techniques adopted for separation of biomolecules.
- CO3: Demonstrate separation of protein by electrophoresis.
- CO4: Separate carbohydrates by paper chromatography,
- CO5: Separate amino acids by paper and thin layer chromatography.
- CO6: Practice isolation of biomolecules from biological samples.
- CO7: Demonstrate isolate and estimate the amount of biomolecules in general.
- CO8: Separate and purify proteins by gel filtration chromatography
- CO9: Separate plant pigments by column chromatography
- CO10: Isolate and separate glycogen from tissues

### **List of Experiments**

#### Biochemical Studies

1. Estimation of Tryptophan
2. Estimation of Lactate
3. Estimation of pyruvate
4. Estimation of protein by Bradfords method
5. Isolation and estimation of DNA,
6. Isolation and estimation of RNA
7. Isolation and estimation of glycogen from tissues.

#### Bioinstrumentation Lab

8. Separation of Aminoacids/ sugars by paper chromatography and TLC
9. Separation of Plant pigments by column chromatography
10. Separation of Proteins by gel filtration chromatography
11. SDS PAGE-Demonstration

### **Text Books**

1. J. Jayaraman, Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers. 2011 (Paperback).
2. S. Sadasivam, A. Manickam, Biochemical Methods. New age publishers. 2009 (paperback).
3. S. K. Sawhney, Randhir Singh, Introductory Practical Biochemistry. Alpha Science International, Ltd. 2 edition, 2005.



**Reference Books**

1. Harold Varley, Practical Clinical Biochemistry, CBS. 6 edition, 2006.
2. Hans Bisswanger, Practical Enzymology. Wiley VCH. 2nd Edition, 2011.
3. Robert Eisenthal, Enzyme Assays: A Practical Approach (Practical Approach Series). Oxford University Press, U.S.A. 2 edition, 2002.

**Course objectives**

This paper aims to provide a basic understanding of biological catalysis, Mechanism of action of enzymes, structure and function relationship, Understanding the enzyme kinetics and role of co-enzymes/co-factors and an overview of Industrial application of enzymes.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Distinguish the fundamentals of enzyme properties, nomenclatures, characteristics and mechanisms.
- CO2: Apply biochemical calculation for enzyme kinetics.
- CO3: Discuss the factors affecting enzymatic reactions.
- CO4: Describe the concepts of co-operative behaviour, enzyme inhibition and allosteric regulation.
- CO5: Compare methods for production, purification, characterization and immobilization of enzymes.
- CO6: Describe the major applications of enzymes in industry, understand the principles of enzyme immobilisation techniques and enzyme extraction procedures
- CO7: Develop new ideas for the development of enzyme-based drugs.
- CO8: Discuss enzymes that are responsible for energy conversion from nutrition
- CO9: Discuss various application of enzymes that can benefit human life
- CO10: Discover the current and future trends of applying enzyme technology for the commercialization purpose of biotechnological products.

**Unit 1 Introduction****(12)**

General introduction, Nomenclature and classification of enzymes, isolation and purification of enzymes –criteria of purity - specific activity. Enzyme units - Katal, IU. Measurement of enzyme activity - . Active site - determination of active site amino acids - chemical probe, affinity label, and site directed mutagenesis. Investigation of 3-D structure of active site. Isoenzymes.

**Unit 2 Kinetics****(12)**

Kinetics of single substrate enzyme - catalysed reactions - Michaelis – Menten equation, importance of  $V_{max}$ ,  $K_m$ , MM equation, and turnover number; Lineweaver - Burk plot, Eadie - Hofstee plot, Hanes - Woolf plot . Kinetics of Allosteric enzymes - MWC and KNF models. Hill' equation coefficient. Kinetics of multi – substrate enzyme - catalysed reactions - Ping-pong bi-bi, random order and compulsory order mechanism.

**Unit 3 Catalysis and Inhibition****(12)**

Mechanism of enzyme action - general acid-base catalysis, covalent catalysis, role of metal ion in enzyme catalysis, mechanism of serine proteases - chymotrypsin, lysozyme, carboxy peptidase A and ribonuclease. Reversible inhibition - competitive, uncompetitive, noncompetitive, mixed, substrate and allosteric inhibition. Irreversible inhibition.

**Unit 4 Coenzymes****(12)**

Coenzymes - prosthetic group and cofactors with examples. Structure, functions and mode of action of TPP (oxidative decarboxylation) , FMN , FAD ,NAD , NADP ( redox reactions), PALP and PAMP – (transamination), Coenzyme A (Acylation/acetylation reactions), biotin – (carboxylation ) , tetrahydro folate (one carbon transfer), cobalamine coenzymes-cyano, hydroxo, methyl and deoxy adenosyl cobalamine- role in methyl group transfer and mutase reactions. Co-enzymic functions of vitamin C, lipoic acid and coenzyme Q in metabolic reactions .

### **Unit 5 Applications of enzymes**

**(12)**

Industrial uses of enzymes - sources of industrial enzymes, thermophilic enzymes, amylases, glucose isomerases, cellulose degrading enzymes, lipases, proteolytic enzymes in meat and leather industry, detergents and cheese production. Immobilization of enzymes, methods and their applications. A brief account of non-protein enzymes - ribozymes and DNA enzymes.

**Total : 60 hours**

### **Text Books**

1. David Nelson and Michael Cox, Lehninger Principles of Biochemistry, 4<sup>th</sup> edition; 2005
2. JL Jain, Sanjay Jain and Nitin Jain, Fundamentals of Biochemistry, 6<sup>th</sup> edition; 2005
3. Donald Voet and Judith Voet, Fundamentals of Biochemistry, 2<sup>nd</sup> edition; 2006
4. MJ Pelczar, ECS Chan and NR Krieg, Microbiology, Tata McGraw Hill Edition, 1998

### **Reference Books**

1. Malcolm Dixon and Edwin Clifford Webb, Enzymes (Volume 6), 1964
2. Trevor Palmer, Understanding Enzymes, 4<sup>th</sup> edition, 1995
3. Robert K Murray , Daryl Granner and Victor W Rodwell, Harper's illustrated biochemistry, 27<sup>th</sup> edition; 2006
4. Julio Polaina and Andrew P MacCabe (Editors), Industrial Enzymes: Structure, Function and Applications (Springer), 2007

**Course objectives**

The paper intends to provide a basic understanding of the biochemical reactions of molecules, Role of enzymes as key elements that govern the biochemical transformations, break-down and synthesis of various biomolecules and the turnover of carbohydrates, proteins, lipids and nucleic acids.

**Course outcomes**

**After the completion of this course, the student will be able to**

- CO1: Discuss the overall concept of cellular metabolism – anabolic and catabolic pathways, energy storage and release, production of building blocks for macromolecule synthesis.
- CO2: Differentiate how various organs control metabolism.
- CO3: Discuss the basics of enzymes, transporters, signal transduction, and mitochondrial structure.
- CO4: Explain glucose homeostasis (pathways and hormonal regulation). Discuss Krebs cycle, electron transport, and the pentose phosphate pathway.
- CO5: Analyze the role of fat in energy production, membrane synthesis, and production of bioactive molecules.
- CO6: Describe the structure, biosynthesis, oxidation and storage of fatty acids.
- CO7: Describe the basic metabolic pathways of cholesterol and lipoproteins.
- CO8: Describe common pathways of amino acid catabolism to release ammonia (handled by the urea cycle) and carbon skeletons.
- CO9: Differentiate between ketogenic and glucogenic amino acids, and diseases resulting from defective catabolism (phenylketonuria, maple syrup urine disease) and biosynthesis of non-essential amino acids.
- CO10: Explain nucleotide biosynthetic pathways. Describe diseases associated with defective nucleotide biosynthesis and therapies that utilize the biosynthetic pathways

**Unit 1 Carbohydrate metabolism****(12)**

Fate of dietary carbohydrates. Glycolysis with energetic & regulation, Cori cycle, Futile cycles in carbohydrate metabolism. Metabolism of Glycogen, TCA cycle - Energetics and its regulation. Pentose phosphate pathway. Uronic acid pathway. Gluconeogenesis pathway and significance. Glycerate cycle.

**Unit 2 Lipid Metabolism****(12)**

Oxidation of fatty acids - Beta oxidation, alpha oxidation and omega oxidation. Metabolism of Ketone bodies - Formation, Utilization, Excretion and significance. Metabolism of Triglyceride, Phospholipids and cholesterol. Biosynthesis of saturated and unsaturated fatty acids.

**Unit 3 Protein Metabolism****(12)**

Introduction, fate of dietary proteins, catabolism of amino acids - transamination, oxidative and non-oxidative deamination, decarboxylation- urea cycle and its regulation.

**Unit 4 Nucleic acid Metabolism****(12)**

Introduction, fate of dietary nucleic acids, catabolism of purine and biosynthesis of purine nucleotides- denovo synthesis and salvage pathways. Regulation of purine biosynthesis. Catabolism of pyrimidines and biosynthesis of pyrimidine nucleotides. De novo synthesis and salvage pathways, regulation of pyrimidine synthesis.

**Unit 5 Biological Oxidation****(12)**

Introduction -free energy - free energy of hydrolysis of ATP and other organophosphates. Role of High energy compounds - Electron transport chain- Components and reactions of ETC. Role of ETC - Oxidative Phosphorylation - Chemiosmotic hypothesis. P/O ratio, uncouplers of oxidative phosphorylation.

**Total : 60 hours****Text Books**

1. David Nelson and Michael Cox, Lehninger Principles of Biochemistry, 4<sup>th</sup> edition; 2005
2. JL Jain, Sanjay Jain and Nitin Jain, Fundamentals of Biochemistry, 6<sup>th</sup> edition; 2005
3. Donald Voet and Judith Voet, Fundamentals of Biochemistry, 2<sup>nd</sup> edition; 2006
4. Lubert Stryer, Jeremy M Berg and John L Tymoczko, Biochemistry 5<sup>th</sup> edition; 2005

**Reference Books**

1. Malcolm Dixon and Edwin Clifford Webb, Enzymes (Volume 6), 1964
2. Robert K Murray , Daryl Granner and Victor W Rodwell, Harper's illustrated biochemistry, 27<sup>th</sup> edition; 2006
3. BD Hames, NM Hooper and JD Houghton, Instant Notes in Biochemistry, 1<sup>st</sup> ed, 1997

**Course objectives**

To Understand and perform, the most recent and important methods in Molecular Biology and also understand the molecular approach used in research relevant for understanding the development and treatment of human diseases.

**Course outcomes**

**After the completion of this course, the student will be able to**

- CO1: Understand the basic principle involved in isolation of biomolecules from various biological sources
- CO2: Isolate DNA from various sources – viz plant, microbes and animals
- CO3: Purify DNA, RNA
- CO4: Separate DNA, RNA
- CO5: Separating Proteins by SDS PAGE
- CO6: Understanding the mobility differences of macromolecules in electrophoresis
- CO7: Understand the optimal conditions essential for protein/nucleic acid separation and purification
- CO8: Determine molecular weight of protein
- CO9: Determine molecular size
- CO10: understand the application of these techniques

**List of Experiments**

1. Separation of proteins by SDS PAGE.
2. Determination of molecular weight of serum proteins by SDS PAGE
3. Study of enzyme activity on Native PAGE.
4. Isolation of plasmid DNA.
5. Isolation of genomic DNA from plant source.
6. Separation of DNA by Agarose gel electrophoresis.
7. Determination of size of DNA by agarose gel electrophoresis
8. RFLP.
9. Gene amplification by PCR.
10. RT-PCR (Demonstration)
11. Southern hybridization (Demonstration).
12. Western blotting (Demonstration).

**References**

1. Michael R. Green, Joseph Sambrook. Molecular Cloning: A Laboratory Manual, 4th Ed.
2. S.K.Sawhney and Randhir Singh. Introductory practical biochemistry. 2<sup>nd</sup> edition.2005. .

3. Roger L. Lundblad, Fiona Macdonald. Handbook of Biochemistry and Molecular Biology, 4<sup>th</sup> Edition. CRC Press, 2010

4. Leland J. Cseke, Ara Kirakosyan, Peter B. Kaufman, Margaret V. Westfall. Handbook of Molecular and Cellular Methods in Biology and Medicine, 3rd Edition, CRC Press, 2011

**Course objectives**

To Understand and perform, the most recent and important methods in Molecular Biology and also understand the molecular approach used in research relevant for understanding the development and treatment of human diseases.

**Course outcomes**

**After the completion of this course, the student will be able to**

CO1: Develop skill in the preparation and sterilization of microbial medias.

CO2: Demonstrates proficiency and use of following in isolation of cultures by various methods (Serial dilution, Pour plate, Spread plate and Streak plate methods)

CO3: Perform Slab culture technique for enabling long term storage of culture medias.

CO4: Identify different types of microbes by various staining techniques (Simple and Differential, Negative and Acid fast staining techniques).

CO5: Explain and perform Spore and capsule staining techniques.

CO6: know the different types of Fungal staining.

CO7: Perform Antibody sensitivity disc-phenol coefficient method.

CO8: Understand and estimate the growth kinetics curve of bacteria.

CO9: Ability to utilize microbiological concepts to summarize, analyse and develop results in study of microorganisms.

CO10: Demonstrates skill in taking up basic research projects and findings by employing microbiological concepts and principles.

**List of Experiments**

1. Preparation of media
2. Sterilization techniques
3. Isolation of pure culture- serial dilution and pour plate method
4. Isolation by Spread plate method
5. Isolation by streak plate methods
6. Slab culture techniques for long term storage.
7. Simple and differential Staining techniques
8. Negative and acid fast Staining techniques
9. Spore and capsule staining
10. Fungal staining.
11. Antibiotic sensitivity disc- phenol coefficient method.
12. Estimation of growth curve of bacteria.

**Reference Books**

1. Michael R. Green, Joseph Sambrook. Molecular Cloning: A Laboratory Manual, 4th Ed.



2. S.K.Sawhney and Randhir Singh. Introductory practical biochemistry. 2<sup>nd</sup> edition.2005. .
3. Mehra, N. K. and Gupta S. K., A Handbook of Practical and Clinical Immunology, 2<sup>nd</sup> ed., 3 vols., CBS Publishers, New Delhi, (1993).
4. Leland J. Cseke, Ara Kirakosyan, Peter B. Kaufman, Margaret V. Westfall. Handbook of Molecular and Cellular Methods in Biology and Medicine, 3rd Edition, CRC Press, 2011

**Course objectives**

Molecular biology deals with nucleic acids and proteins and how these molecules interact within the cell to promote proper growth, division, and development. It is a large and ever-changing discipline. This course will emphasize the molecular mechanisms of DNA replication, repair, transcription, protein synthesis, and gene regulation in different organisms.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Understand the basics of heredity population genetics and master fundamental genetic calculation
- CO2: Understand the synthesis of DNA and Post replication processes
- CO3: Understand the synthesis of RNA and post transcriptional modifications
- CO4: Understand the synthesis of protein and its post translational modifications
- CO5: Describe how gene expression is regulated at different levels, how tissue-specific expression is achieved and exemplify how gene expression can be manipulated and studied experimentally
- CO6: Account for the molecular mechanisms regulating and controlling cell division and the cell cycle and exemplify how extracellular signals affect cell division
- CO7: Describe the molecular mechanisms behind DNA damage and repair
- CO8: Describe and compare different molecular mechanisms to bring about cell death and explain how this is linked to DNA damage
- CO9: Explain how molecular defects in a cell can lead to its development into a cancer cell
- CO10: Explain and compare different principles of how extracellular signals can reach the cell interior, be amplified, transmitted and terminated, and exemplify how signal routes are integrated and how specificity can be achieved

**Unit 1 Genetics****(12)**

Gene concept and interaction of genes. Molecular structure of genes and chromosomes. Mendel's work on heredity, Mendel's mono and dihybrid experiments. Mendel's Laws, Linkage and crossing over, coupling and repulsion hypothesis, sex linked inheritance. Non-chromosomal inheritance.

**Unit 2 Replication****(12)**

Evidences for DNA as the genetic material. Structural organization and functional elements of eukaryotic chromosomes. Prokaryotic and Eukaryotic replication, Regulation of replication, Mutation, DNA Repair, Recombination.

**Unit 3 Prokaryotic Transcription****(12)**

Prokaryotic transcription. Inhibitors of transcription. Post transcriptional processing of rRNA and tRNA. Regulation of transcription in prokaryotes– the lac operon, negative and positive regulation and tryptophan operon.

**Unit 4 Eukaryotic Transcription****(12)**

Eukaryotic transcription and regulation. RNA polymerase I,II and III, promoters, transcription factors, Transcription factor motifs, Activators, repressors and enhancers, transcription complex assembly and mechanism of transcription. Post transcriptional processing of mRNA, rRNA and tRNA. Splicing, Alternative splicing, catalytic RNA (ribozymes), RNA editing, Antisense RNA.

**Unit 5 Translation****(12)**

Genetic code and translation. The genetic code – general features, Deciphering the code, Wobble Hypothesis. Translation- activation of aminoacids, initiation, elongation, termination in prokaryotes and eukaryotes. Regulation of gene expression in eukaryotes. DNA methylation, chromatin remodelling, DNA response elements, degradation of proteins. Protein sorting, targeting of proteins to mitochondria, chloroplast and nucleus, Receptor mediated endocytosis

**Total : 60 hours****Text Books**

1. De Robertis, Cell and molecular biology. Dhanpat Rai Publisher, 8<sup>th</sup> Edition, 2001.  
Nalini Chandar, Susan Viselli, Lippincott Illustrated Reviews: Cell and Molecular Biology. LWW : North American Edition ( 2010).
2. Robert Franklin Weaver, Molecular Biology. Mc-Graw Hill science, 5<sup>th</sup> edition, 2011.

**Reference Books**

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Molecular biology of the cell. Garland Science, 6<sup>th</sup> edition (2014).
2. Benjamin Lewin, Genes IX. Jones & Bartlett Learning; 9 edition ( 2007).
3. Harvey Lodish, Arnold Berk & Chris A. Kaiser, Molecular Cell Biology. W. H. Freeman; 6th edition ( 2007).
4. James D. Watson, Tania A. Baker, Stephen P. Bell, Molecular Biology of the Gene. Benjamin Cummings, 7th Edition ( 2013).
5. Gerald karp, Cell and Molecular Biology: Concepts and Experiments, Wiley; 7th Edition edition (2013).

**Course objectives**

The course aims to provide an advanced understanding of the biochemical mechanisms and pathophysiological processes responsible for common biochemical disorders. The course provides an overview of normal and abnormal metabolic functions, the impact of disorders on metabolic processes, an overall picture about the molecular basis of diseases and novel strategies to prevent the diseases.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Understand the Basic concepts and principles of Clinical Biochemistry, detail on the various biological specimens including the process of collection, preservation and storage.
- CO2: Gain Knowledge on the collection, and analysis of Amniotic fluid and on the Immunological tests related to diagnosis of anomalies during pregnancy.
- CO3: Understand the Blood groups, Blood banking and adverse reactions of blood transfusions.
- CO4: Describe of the blood clotting pathways and the blood clotting disorders.
- CO5: Enumerate of the different types of anemias based on aetiology.
- CO6: Understand the pathophysiological processes responsible for common biochemical disorders such as jaundice, Pancreatitis, Fatty liver etc.
- CO7: Differentiate three types of jaundice and their systematic analysis. Detailed study of Jaundice, Cirrhosis, Hepatitis, Fatty liver and gall stones. Serum enzyme activities in diseases.
- CO8: Understand Formation of urine and gain perception on the various renal function tests and renal disorders
- CO9: Gain understanding of the need for Gastric function tests, Collection of gastric contents, their examination.
- CO10: Appreciate the Clinical application of enzymes in diagnosis, Discussion on Isozymes and understanding their role in diagnosis. Understanding the enzyme patterns in diseases of various organs such as pancreas, liver, bones, heart and muscle.
- CO11: Understand the aetiology, types, clinical manifestations and treatment of Diabetes mellitus and various disorders of carbohydrate metabolic pathways.
- CO12: Understand on the etiology, types, clinical manifestations, diagnosis and treatment of various aminoacidurias.
- CO13: Detail the nucleic acid metabolism disorders.
- CO14: Elaborate on the role of Serum lipids including triglycerides, cholesterol and phospholipids in diseases. Detail the clinical role of serum cholesterol and state the

Clinical features of atherosclerosis.

CO15: Understand the molecular basis of Cancer – cancer cells, difference between cancer and normal cells. To identify the various diagnostic approaches – CT, MRI, PET and SPECT and learn about Tumor markers.

**Unit 1 Introduction and Diseases of the new-born (12)**

Introduction to Basic concepts and principles of Clinical Biochemistry .Standard values for important constituents in blood and urine. Specimen collection and Processing of blood and urine. Anticoagulants. Blood groups, Blood banking and adverse reactions of blood transfusions. Hemolytic diseases of the new born. Hemoglobinopathies, Thalassemias Haemophilias. Anaemias.

Amniotic fluid-origin, collection, composition and analysis. Immunological tests of pregnancy. Prenatal detection of inborn errors of metabolism in the fetus by enzyme assays in amniotic fluid.

**Unit 2 Liver function tests and related disorders. (12)**

Jaundice, Cirrhosis, Hepatitis, Fatty liver and gall stones. Serum enzyme activities in diseases. Renal function tests and related disorders - Acute and chronic renal failure, glomerular diseases and tubular diseases, urinary tract obstruction and analysis of urinary calculi. .

**Unit 3 Other organ function tests (12)**

Assessment of Gastric function Tests, Pancreatic function test and Intestinal function tests. Enzyme parameters in these pathological conditions.

**Unit 4 Metabolic disorders (12)**

Disorders of carbohydrate metabolism nucleic acid metabolism and lipid metabolism and their diagnosis. Aminoacidurias.

**Unit 5 Cancer (12)**

Diagnosis of Cancer – cancer cells, difference between cancer and normal cells. Diagnosis – Tumor markers, classification, functions. Medical imaging techniques – CT, MRI, PET and SPECT.

**Total : 60 hours**

**Text Books**

1. M.N. Chatterjee & Ranashinde, Text Book of Medical Biochemistry. Jaypee Publisher. 6<sup>th</sup> edition, 2006.
2. Nanda Maheshwari, Clinical Biochemistry. JPB. First edition, 2008.
3. Nessar Ahmed, Clinical Biochemistry, . Oxford University Press. 1st Edition, 2011.

**Reference Books**

1. Carl A. Burtis, Edward R. Ashwood and David E. Bruns (eds), Tietz Textbook of Clinical Chemistry and Molecular Diagnosis. 5th edition, 2012.
2. Thomas M. Devlin, Biochemistry with clinical correlation. John Wiley & Sons. 7th Edition, 2010.

3. Allan Gaw, Michael J. Murphy, Rajeev Srivastava, Robert A. Cowan, Denis St. J. O'Reilly, Clinical Biochemistry. 5<sup>th</sup> edition, 2013.
4. Graham Basten, Introduction to Clinical Biochemistry, Interpreting Blood Results. BookBoon. 2<sup>nd</sup> edition, 2011.
5. Lawrence A. Kaplan, Amadeo J. Pesce, Clinical Chemistry: Theory, Analysis, Correlation .Mosby. 5 edition, 2009.

**Course objectives**

Clinical biochemistry is a scientific discipline within medicine. It includes the analysis of body fluids, cells and tissues and interpretation of the results in relation to health and disease. The discipline encompasses fundamental and applied research into the biochemical and physiological processes of human and animal life, and application of the resulting knowledge and understanding to the diagnosis, treatment and prevention of disease.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Gain knowledge of biological samples and their collection procedures
- CO2: Perform biochemical laboratory analysis in blood and urine samples and interpret the generated results after analysis in order to determine the likely diagnosis
- CO3: Distinguish serum, plasma and whole blood emphasizing the role of anticoagulants
- CO4: Assess presence and absence of normal and abnormal constituents in urine by performing qualitative urine analysis
- CO5: Analyze blood for RBC, WBC, TC/DC, ESR and hemoglobin by performing hematological assays
- CO6: Determine activity of enzymes such as SOD, catalase, GPx, creatine kinase, LDH, Na K ATPase, SGOT and SGPT.
- CO7: Determine blood urea, uric acid and creatinine which acts as renal indices
- CO8: Analyze serum for cholesterol, bilirubin and A/G ratio
- CO9: Analyze blood for glucose level
- CO10: Assess calcium and vitamin A and E in blood

**List of Experiments**

## Analysis of Biological Samples

1. Hematological analysis-RBC, WBC-TC/DC, Hemoglobin content and ESR
2. Analysis of normal and abnormal urine constituents
3. Estimation of Calcium

## Enzyme assays

4. Assay of Enzymic antioxidants-SOD, Catalase and GPx
5. Assay of Creatine kinase, LDH and Na K ATPase
6. Assay of SGOT/ SGPT

## Biochemical Studies

7. Estimation of renal indices-Urea, Uric acid and Creatinine.
8. Estimation of Blood Glucose
9. Estimation of Serum Bilirubin
10. Estimation of A:G ratio in serum

11. Estimation of serum Cholesterol.

12. Estimation of Vitamins-A & E

**Text Books**

- 1 J. Jayaraman, Laboratory Manual in Biochemistry. New Age International Pvt Ltd Publishers. 2011 (Paperback).
- 2 S. Sadasivam, A. Manickam, Biochemical Methods. New age publishers. 2009
- 3 S. K. Sawhney, Randhir Singh, Introductory Practical Biochemistry. Alpha Science International, Ltd. 2 edition, 2005.

**Reference Books**

- 1 Harold Varley, Practical Clinical Biochemistry, CBS. 6 edition, 2006.
- 2 Hans Bisswanger, Practical Enzymology. Wiley VCH. 2nd Edition, 2011.
- 3 Robert Eisenthal, Enzyme Assays: A Practical Approach (Practical Approach Series). Oxford University Press, U.S.A. 2 edition, 2002.



**Course objectives**

This paper provides a complete understanding of the responses of the human body to toxic agents and the therapeutic approaches to toxicity. The paper also deals with the forensic aspects like legal procedures and types of trauma.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Understand the basic concepts of toxins and the biochemical basis of their toxicity
- CO2: Know the different types of poisons and their effects
- CO3: Know the poison associated effects under Forensic Science
- CO4: Have the knowledge about legal procedures in India and the proceedings involved in criminal cases
- CO5: Have basic understanding of identification procedures employed under Forensic toxicology
- CO6: Have knowledge about identification of different types of injuries
- CO7: Gain knowledge about the medico-legal implications associated with different types of injuries
- CO8: Have knowledge about causes of death by different means and the associated medico-legal aspects
- CO9: Basic understanding of fingerprint analysis and interpretations
- CO10: Basic understanding of isolation of DNA from available biological samples and its analysis by DNA fingerprinting method

**Unit 1 Introduction to toxicology (12)**

Fundamentals of Toxicology and dose-Response Relationships. Factors Affecting Toxic Responses: Disposition : Absorption ,Sites of absorption, distribution, Excretion; Metabolism: types of Metabolic change phase I reactions; Phase 2 reactions; control of Metabolism, Toxication vs. Detoxication.

Biochemical basis of toxicity: Mechanism of toxicity: Disturbance of excitable membrane function, Altered Calcium homeostasis, Covalent binding to cellular macromolecules & genotoxicity, Tissue specific toxicity

**Unit 2 Clinical toxicology (12)**

Types of poison, Clinical signs and Symptoms, diagnosis, management and medicolegal aspects of corrosive poisons; irritant poisons; neural poisons; somniferous; inebriant; deliriant; spinal; peripheral; cardiac poisons; asphyxiants; drug abuse.

**Unit 3 Introduction to forensics (12)**

Legal procedures in India; medical and medico Legal documents; evidences, witnesses; laws related to medical profession. Medical Council of India, State Medical Council: structure, functions, powers; duties of medical practitioners towards patients and relatives, medical

negligence: civil, criminal; Consumer Protection Act: rights and liabilities of doctors, medical indemnity insurance; human rights and violation; duties of medical practitioners to victims of torture; Human organ transplantation Act.

**Unit 4 Identification procedures (12)**

Identification of the living and the dead. Forensic thanatology; death; causes of death; mechanism and manner of death; changes after death; artifacts; medico-legal death investigation; exhumation. Forensic science; Locard's exchange principle; lie detector; superimposition; DNA finger printing, HLA typing.

**Unit 5 Pathology (12)**

Injuries - mechanical injuries; injuries; injuries; injuries due to electricity, lightning and radiation; train and road traffic accidents; firearm and explosion injuries; medico legal aspects of wounds.

General aspects; patho-physiology and classification ;mechanical asphyxia; hanging; strangulation; drowning; smothering, choking, garroting, burking, yoking.

**Total : 60 hours**

**Text Books**

1. Narayanareddy K. S., The Essentials of Forensic Medicine & Toxicology, 2007Published by K. Sugana Devi, 26<sup>th</sup> Edition, Hyderabad.
2. Basu, R. Fundamentals of forensic medicine and toxicology. 2009. 2nd Edition. Books and Allied(P) Ltd. Kolkata.

**Reference Books**

1. Parikh C.K. Parikh 's Textbook of Medical Jurisprudence and Toxicology, Publishers Bangalore . 6<sup>th</sup> Edition 1999, Reprint 2007
2. Franklin, C.A Modi's medical Jurisprudence and Toxicology, published by M. Tripathi Private Limited, 21<sup>st</sup> Edition. Bombay.
3. Keith Simpson, Bernard Knight, 1988, Forensic Medicine, ELBS. 9<sup>th</sup> Edition
4. Pillay V.V., Text book of Forensic Medicine,2009, Paras Publication. Hyderabad
5. JB Mukherjee's Forensic Medicine and Toxicology – Volume I and II (combined)-edited by Karmakar ,III Edition 2007.

## **DISCIPLINE SPECIFIC ELECTIVES**

**Course objectives**

The objective is to impart knowledge and understanding of the human body. To understand the inter relationships within and between anatomical and physiological systems of the human body.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Understand the inter relationships within and between anatomical and physiological systems of the human body
- CO2: Describe the structure of major human organs and explain their role in the maintenance of healthy individuals.
- CO3: Understand the role of Membranes and its transport mechanism.
- CO4: Know in detail about the 4 levels of biological tissues.
- CO5: Describe the general function of each organ system.
- CO6: Explain how the activities of organs are integrated for maximum efficiency
- CO7: Have in-depth understanding of neurophysiology
- CO8: Have in-depth understanding of anatomy and physiology of respiratory, digestive, and vascular system
- CO9: Have in-depth understanding of anatomy and physiology of muscle physiology
- CO10: Identify how changes in normal physiology lead to disease

**Unit 1 Basics of Human anatomy****(09)**

Definition and scope of anatomy, physiology and related sciences. Anatomical terms in relation to parts of the body, system and organs.. Cell- Structures and their functions. Tissues of the Body- Types of tissues and their functions. Muscles – structure, types and functions.

**Unit 2 Digestive system****(09)**

Structure and functions of alimentary canal - mouth, oesophagus, stomach, small intestine, large intestine. Digestive enzymes, zymogens – salivary gland, gastric gland, liver, pancreas and intestinal glands. Digestion and absorption of carbohydrates, fats and proteins. Defaecation.

**Unit 3 Blood and Respiratory system****(10)**

Composition of blood. Structure, of RBC, WBC and platelets. Blood clotting – blood clotting factors and mechanism of blood clotting. Haemostasis. Blood groups- ABO system and Rhesus system. Structure of Respiratory system. Functions of pharynx, larynx, trachea, bronchi and bronchioles and lungs. Physiological and biochemical events of respiration – Breathing, exchange of gases and regulation of respiration- Bohr effect and role of 2,4 DPG.

**Unit 4 Nervous system (10)**

Nervous System - General physiology of neurons, synapses, neurohumoral transmission.

Central nervous system, its various parts and their functions. Structure and functions of the urinary system - kidneys, ureter, urinary bladder and urethra. Micturition. Mechanism of urine formation –GFR, tubular reabsorption and tubular secretion. Role of ADH.

**Unit 5 Reproductive system (10)**

Structure and functions of male reproductive system`. Structure and functions of female reproductive system – Ovulation, menstrual cycle. Spermatogenesis and factors influencing sperm count and viability. Biochemistry of fertilization. Physiological changes during pregnancy, parturition and lactation.

**Total : 48 hours**

**Text books**

1. Guyton AC. Text book of Medical Physiology, 8th Edition. Prism books (pvt), Bangalore, India. ... TATA McGraw-hill publishing Company, 1991.
2. C.C. Chatterjee, "Human Physiology"(Vol. I & Vol. II), Medical Allied Agency, Calcutta, 11th edition, 1985.

**Reference books**

1. Ganong (Williams) Review of medical physiology 25<sup>th</sup> edition. 2015. McGraw-Hill/Appleton & Lange.
2. Ross and Wilson. Anatomy and physiology. In health and illness. 12<sup>th</sup> edition, 2014. Churchill livingstone Elsevier.

**Course objectives**

Cell biology is increasingly important in all life sciences. Many of the advancements in modern science are the result of a better understanding of cellular components and their functions. An understanding of cell biology is an asset in modern science, it provides knowledge about the composition, structure and function of organelles and other cellular components and their biological activities.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Describe the origin of life, from the abiotic world to multicellular organisms, including an account of endosymbiosis
- CO2: Explain the structural characteristics of prokaryotic and eukaryotic cells
- CO3: Explain the structure, properties and functions of various classes of macromolecules in cells
- CO4: Describe the intricate relationship between various cellular organelles and their corresponding functions
- CO5: Explain organization of DNA and its involvement in the process of inheritance
- CO6: Enumerate the structure and functions of the plasma membrane
- CO7: Explain membrane physiology to include transport mechanisms, membrane potentials and action potentials
- CO8: Explain how specific components of the cytoplasmic cytoskeleton are structured and function
- CO9: Explain the way in which cells divide to enable growth and reproduction and the genetic controls on division
- CO10: Assess the mechanisms underlying cell differentiation, cell-cell communication, cell recognition, cell Adherence, cell senescence and death.

**Unit 1 Introduction to cell and cell membrane****(10)**

Cell as a basic unit of living system. Biochemical composition of cell: protein, lipid,

carbohydrate, nucleic acid. The cell theory. Ultrastructure of cell. Membrane composition, lipid bilayer/membrane. Membrane functions – simple diffusion, Facilitated transports. Active transport, Endocytosis, Pinocytosis, Phagocytosis, Exocytosis.

**Unit 2 Organelles (10)**

Structure and Function of the Endoplasmic reticulum, Golgi complex, Lysosome, Ribosome, Mitochondria and Chloroplast.

**Unit 3 Nucleus (09)**

Structure and Function of Nucleus, Nuclear envelope, Structure of Chromatin, Organization of chromatin. Structure and functions of nucleolus.

**Unit 4 Dynamics of the cell (09)**

Cell cycle, Cell- cell interaction, recognition and adhesion, Cell locomotion (amoeboid, flagellar and ciliar). Cell senescence and death. Cell differentiation.

**Unit 5 Cytotechniques (10)**

Methods of Cell Study: Simple and compound microscope, Phase contrast, dark field and polarization microscopy, Electron microscopy, SEM, TEM; freeze fracture.

Fluorescence and Confocal microscopy; imaging live cells. FRET and FRAP. Atomic force microscopy. Flow -Cytometry and cell sorting (FACS). Plant tissue culture. Animal and insect tissue culture. Methods of cell disruption and fractionation, isolation of organelles.

**Total : 48 hours**

**Text Books**

1. Devasena.T, Cell Biology. Oxford University Press India; First edition (2012).
2. Rastogi . S.C, Cell Biology. newagepublishers (2008).

**Reference Books**

1. David L Nelson & Michael M Cox, Lehninger -Principles of biochemistry.W.H. Freeman company New York 4<sup>th</sup> edition 2007.
2. Garrett Grisham, Biochemistry. International student's edition. 3<sup>rd</sup> edition
3. Karp G, Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc. 6<sup>th</sup> Edition.2010
4. De Robertis E.D.P & De Robertis E.M.F. Cell and Molecular Biology.2006.
5. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. Sinauer Associates, Inc.; 6 edition,2013.

**Course objectives**

The course was designed in such a way to get hands on training in the Biochemical methods in the aspect of doing research and to impart the knowledge of Statistics and Design of Experiments to the students. This will help the students to have focused idea about the research methodologies and how to write research findings with the help of biostatistics and computer.

**Course outcomes**

**After the completion of this course, the student will be able to**

- CO1: Explore the basic components of computer and methods of protecting system from virus.
- CO2: Learn the applications of packages like WORD, EXCEL, Power Point in entering data, preparing tables, graphs, charts etc.,
- CO3: Study applications of statistical tools like Mean, Median, Mode, Standard deviation, Standard error, 't' test and ANOVA in biological research.
- CO4: Learn usage of statistical software like SPSS, Graph pad
- CO5: Understand the general principle, Instrumentation and applications of PCR  
RAPD, RFLP, blotting in molecular biology research.
- CO6: Understand the general principle, Instrumentation and applications of RAPD, RFLP
- CO7: Understand the general principle, Instrumentation and applications of blotting techniques
- CO8: Gain some knowledge on principle, instrumentation and applications of immunological techniques like ELISA, RIA, CRYOPRESERVATION.
- CO9: Explore selection of test material, designing an experiment, different methods of literature collection.
- CO10: Learn how to prepare a dissertation, preparation of articles, communication of articles to journals

**Unit 1 Fundamentals of Computers****(10)**

Computer in Biological Research - Components of Computer - storage device, computer peripherals, Computer virus Protection. Word Basics- Creating and working with documents, working with text Tables, Using EXCEL-working with work sheet, Creating chart- working with



formula and functions, Using power point-working with power point user interface, Using templates and wizard for Slide Presentation, Creating charts and tables, Internet and WWW, Electronic mail- internet browsing.

**Unit 2 Biostatistics and Research - I (10)**

Steps in Scientific research, Sample - Variables, Graphic Representation, Frequency Distribution- Types, Mean, Mode and Median and measures of central tendencies, Standard Deviation and Related measures

**Unit 3 Biostatistics and Research - II (10)**

Biostatistics and Research- Probability- Hypothesis testing for Significance. Chi Square and Students Test, Regression and correlation- ANOVA, TUKEY's TEST and DUNCUN's TEST. Introduction to statistical softwares.

**Unit 4 Molecular Techniques (09)**

PCR, RAPD, RFLP, BLOTTING Techniques, Immunological techniques - ELISA, RIA. Basic concepts of cryopreservation,.

**Unit 5 Thesis Preparation and Writing (09)**

Basics Steps in research –Problem Selection- Experimental design- Review of Literature- Types of Literature- Reprint requisition, Preparation of Research Report/ Dissertation/Review- Abstract, Short notes, Contents of Dissertation (Introduction, Methodology, Results, Discussion, Summary, References/ Bibliography), Citation of Reference- Presenting Tables, Figures, Plates, Annexure, Acknowledgement, Formatting and Typing- Proof Reading.

**Total : 48 hours**

**TextBooks**

1. Levin and Rubin, Statistics for Management, 1998, 7<sup>th</sup> Edition, Prentice hall of India.
2. N. Gurumani, Research Methodology for Biological Science, 2006, MJP Publisher

**Reference Books**

1. Anderson.j.et al, Thesis and assignment writing, 1970, Wiley eastern Pvt. Ltd. Delhi
2. Alexis Lcon and Mathew's icon, Fundamentals of Information Technology, 1999, Wikas Publisher.
3. C. R. Kothari, Research Methodology: Methods and Techniques, 2005. 2nd Edition, New Age international(P) Limited, India,

**Course objectives**

This paper deals with the study of the physical, chemical, biochemical and biological properties of drugs, drug substances or potential drugs of natural origin as well as the search for new drugs from natural sources. It enables the students to study procedures undertaken to ensure the identity and purity of a particular pharmaceutical compounds.

**Course outcomes**

**After the completion of this course, the student will be able to**

- CO1: Understand the basic terminologies: pharmacognosy, medicinal plant, crude drug, folk medicine and flora.
- CO2: Classify herbal drugs according to botanical origin, chemical constituents, and medicinal activity.
- CO3: Explain different methods of cultivation, collection, curing, drying, adulteration and storage of medicinal plants.
- CO4: Discuss different types of plant cells, secretory structures, different classes of secondary metabolites and their chemical identification.
- CO5: Describe methods for detection and identification of natural drugs, especially leaves, fruits, seeds, herbs, barks and wood macro- and micro-morphologically and chemically.
- CO6: Design suitable natural drug formulations whether in entire, powdered forms according to pharmacopoeial criteria.
- CO7: Summarize different methods of commercial production of medicinal plants.
- CO8: Evaluate the purity of the medicinal drug as well as detection of its adulteration.
- CO9: Develop effective drug delivery system of natural products.
- CO10: Apply pharmacovigilance in herbal therapy and establish authentic standards. Prepare necessary documents for natural product development.
- CO11: Know procedures for clinical trials of herbal products.

**Unit 1 Phytoconstituents of medicinal importance I (10)**

Glycosides, Anthraquinones. Flavonoids (definition, natural sources, classification, biogenesis, extraction, isolation, identification and therapeutic applications). Anthocyanins Coumarins, Terpenes, Volatile Oils (definition, classifications, natural sources, medicinal and non medicinal uses, pharmacological and toxicological effects).

**Unit 2 Phytoconstituents of medicinal importance (10)**

Saponins and Alkaloids (definition, natural sources, classification, physical and biological properties, localization, nomenclature, physico-chemical properties, extraction, detection, isolation, purification, biosynthetic origin and pharmacological activities).

**Unit 3 Pharmacognosy (10)**

Historical development, modern concept and scope of Pharmacognosy. Significance of Pharmacognosy in various systems of medicine *viz*; Ayurveda, Unani, Homeopathic, Siddha and Allopathic systems practiced in India. Common drugs of plant origin. Quantitative microscopy- an overview. Importance of authentication of plants. Preparation of herbal extracts. Natural pesticides and Insecticides-Tobacco, Pyrethrum, Neem. Introduction to herbicides and fungicides. Study of Indian toxic plants.

**Unit 4 Pharmaceutical regulations (09)**

Harmonization of regulatory requirements including ICH activity. Regulatory requirements of different regions applicable to pharmaceutical developments, manufacturing, quality control on finished products, extended release products, biopharmaceutical and bioequivalence assessment and good clinical practices and comparison with regulation in India. Filing of INDA, NDA and ANDA for approval and registration.

**Unit 5 Stability testing (09)**

Role of stability testing, stability test guidelines. Protocol of stability testing including testing under different climatic zones and conditions. Conduct of stability testing, presentation and recording of stability data, determination of shelf life. Stability test equipment and recent developments in this area.

Documentation: Importance of documentation, statutory requirements and procedure for documentation, critical examination of documents.

**Total : 48 hours**

### **Text Books**

1. C.K. Kokate, A.P. Purohit and S.B. Gokhle, Pharmacognosy, Nirali prakasham, 42<sup>nd</sup> edition: sep 2008.
2. Gupta, Vijay Kumar and Singh, Medicinal plants: Phytochemistry , Pharmacology and Therapeutics –Vol 3, Daya publishing house, 1<sup>st</sup> edition, 2014.

### **Reference Books**

1. Herbal Medicines, A Guide for Health Care Professionals- By Carol A. Newal, Linda A. Anderson and J. David Phillipson. (1997).
2. Biren Shah, Avinash seth, Text books of Pharmacognosy and Phytochemistry; Elsevier india publishers, 1<sup>st</sup> edition,2012.
3. Ashutosh Kar, Pharmacognosy and Pharmacobiotechnology; New age india (P) ltd publisher; 2<sup>nd</sup> edition, 2007.

**Course objectives**

This paper assures that Biochemists should have strong ideas about Microbes and their applications, immunity, antigens, antibodies against them, mechanism of action of immune system.

**Course outcomes**

**After the completion of this course, the student will be able to**

- CO1: Demonstrate various classes and structure of microbes. Applications of microbes in food industry and pharma industry.
- CO2: Discuss preparation and applications of products from industries. Role of microbes in nitrogen fixation, purification of water,
- CO3: Discuss the classification of immunity, cell mediated immune response, humoral immune response.
- CO4: Explain the structure, types of antigens and antibodies.
- CO5: Explain active and passive immunity
- CO6: Elaborate the method of monoclonal antibodies synthesis and various theories adopted for production of antibody.
- CO7: Discuss different types of vaccines synthesized and applications.
- CO8: Be aware on immune deficiency disorder and its types, AIDS.
- CO9: Explore knowledge on autoimmune disorder, hypersensitivity and its types.
- CO10: Learn about transplantation, acceptance and rejection of graft.

**Unit 1 Basics of Microbiology****(09)**

History and scope of Microbiology. Classification of microbes. Ultra structure of Bacteria , Fungi , virus , Algae. Food and dairy Microbiology: Role of Microorganism in food production – Dairy and non dairy products, fermented and alcoholic beverages. Antimicrobial agents – physical and chemical agents. Antiseptics and sterilants. Pharmaceutical Microbiology: Production of antibodies , Vaccines, antisera.

**Unit 2 Industrial Microbiology (10)**

Products of Industrial Microbiology- Penicillin, ethanol, Vitamin-B12, Citric acid, Amylase, Protease. Soil & Environmental Microbiology: Nitrogen fixation – symbiotic, asymbiotic. Pollution of water by microbes – sewage treatment, Bioremediation.

Clinical Microbiology: Infection – types of infection, method of infection, factors influencing infection. Normal microbial flora and pathogenic microbes. Bacterial diseases - typhoid, cholera. Viral diseases - Hepatitis, HIV.

**Unit 3 Immunity (10)**

Immunity and its types- innate immunity, acquired immunity, active and passive immunity, Humoral and cellular immunity. Cells of the immune system. Complement pathway.

Immunoglobulins- structure, function and types. Antigens- nature, immunogenicity, haptens. Molecular mechanism of generation of antibody diversity. Monoclonal antibody – preparation and application in clinical research. Antigen-antibody reactions: precipitation, agglutination, Complement fixation test, tissue typing, ELISA, RIA, immunofluorescence, Immunodiffusion; Immunoblot.

**Unit 4 Hypersensitivity (10)**

Hypersensitivity reactions- type I, II, III, IV. Immunological tolerance & autoimmunity. Vaccines- active and passive immunization, commonly used toxoid vaccines, killed vaccines, live attenuated vaccines and bacterial polysaccharide vaccines.

**Unit 5 Transplantation and cancer immunology (09)**

Transplantation immunology- clinical manifestation, therapy, bone marrow and organ transplants. Cancer immunology- tumor antigens, immune response to tumors, immunotherapy. Structure and functions of MHC, association of MHC with disease susceptibility. Immunodeficiency disorders.

**Total : 48 hours**

**Textbooks**

1. Microbiology- Prescott 2003 , 3<sup>rd</sup> edition, Magraw hill , Boston.
2. Roitt, Brostoff, Mal, Immunology, 6<sup>th</sup> edition, 2001

**Reference Books**

1. Panicker , Microbiology, orient Longman , Hyderabad, 6<sup>th</sup> edition, 2005.
2. M.J.Pelzar, Microbiology, Tata mac hran, Hill New Delhi, 5<sup>th</sup> edition, 2005.
3. Donald.M.Weir, Immunology, John Stewart, 7<sup>th</sup> edition, 1993
4. P.M.Lydyard, A.Whelan, M.W. Fanger, Immunology, 2003

**Course objectives**

The content of the syllabus consist of basic biotechnology and its application such as new tools , products developed by biotechnologists such as cell culture, transgenic animals, Genetic engineering are useful in research, agriculture, industry and the clinic. It also helps to understand the Basic principles involved in Intellectual properties rights , scope and importance of marketing and its systems.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Explain the general principles of generating transgenic plants, animals and microbes.
- CO2: Identify and debate the ethical, legal, professional, and social issues in the field of biotechnology and design and deliver useful modern biotechnology products to the Society.
- CO3: Understand the role of vectors, plasmids in gene technology
- CO4: Understand the gene transfer methods
- CO5: Understand the DNA sequencing methods
- CO6: Identify different types of Intellectual Properties (IPs), the right of ownership, scope of protection as well as the ways to create and to extract value from IP.
- CO7: Identify, apply and assess issues relating to each of the relevant areas of intellectual property in various fields of scientific research.
- CO8: Recognize the crucial role of IP in organizations of different industrial sectors for the purposes of product and technology development.
- CO9: Understand the potential role of ownership rights and marketing protection in encouraging, or discouraging, scientific research.
- CO10: Be familiar with the processes of Intellectual Property Management (IPM) and various approaches for IPM and conducting IP and IPM auditing and explain how IP can be managed as a strategic resource and suggest IPM strategy.

**Unit 1 Vectors****(10)**

Restriction enzymes and joining DNA molecules by DNA ligase, double linkers, adaptors, homopolymer tailing. Plasmids vectors (pBR322, pUC 18), phage vectors (M13), cosmids,

expression vectors, yeast vectors –YAC. Selection and screening of recombinants by genetic methods, immunochemical methods, nucleic acid hybridization methods. Synthesis of probes by radioactive and non–radioactive labeling. Analyzing DNA sequences by Maxam and Gilbert method and Sanger’s methods.

**Unit 2 Gene transfer methods (09)**

Introduction of Foreign Genes into Cells using direct gene transfer methods - electroporation, biolistic transfer, transfection, microinjection, lipofection and ultrasonication. Genomic DNA libraries, chromosome walking, cDNA cloning, PCR, RAPD and RFLP.

**Unit 3 Cell culture (10)**

Cell and organ culture, primary cell culture, serum and serum free media, transfer of genes into animal cells in culture. Viral vectors: SV40, retrovirus and adenovirus. In vitro fertilization and embryo transfer. Selectable markers and reporter transgenes. Gene therapy and Antisense therapy.

**Unit 4 Transgenic animals (10)**

Production of medically important biomolecules - insulin, growth hormone, interferons, blood proteins, vaccines, lymphokines and monoclonal antibodies. Production of transgenic animals – transgenics and knock-outs. Production of transgenic sheep, cattle, pigs, fish etc. Development and applications of transgenic animals.

**Unit 5 IPR (09)**

Intellectual Property Rights (IPR) and Protection, Intellectual Property rights for Plant Breeding, Biosafety in biotechnology and Bioethics. Biotechnology Entrepreneurship.

**Total : 48 hours**

**Text Books**

1. Sathyanarayana, Biotechnology, Books and allied Publishers, 3<sup>rd</sup> edition, 2006
2. RC Dubey, Text book of Biotechnology , S. Chand & Co, 2009

**Reference Books**

1. Brown TA “Gene cloning: An introduction” Nelson Thornes, 3<sup>rd</sup> edition, 1995
2. SS Purohit. Biotechnology Fundamentals and applications. Agrobios Publication. 4<sup>th</sup> edition. 2007
3. SB Primrose & R Twyman. Principles of gene manipulation and genomics. Blackwell publishing. 7<sup>th</sup> edition. 2006.
4. PK Gupta, Biotechnology and genomics. Rastogi Publication. 2<sup>nd</sup> reprint. 2006.



**Course objectives:**

The objective is to make a connection between knowledge of anatomy and physiology and real-world situations, including healthy lifestyle decisions and homeostatic imbalances.

**Course outcomes****After the completion of this course, the student will be able to**

CO1: Gain knowledge about the human anatomy and physiology

CO2: Gain insights about the current lifestyle as a consequence of industrialization

CO3: Understand global scenario on sedentary lifestyle nutrition

CO4: Understand Basics of nutrition, RDA, balanced diet and BMR

CO5: Gain knowledge about cardiovascular system and associated disorders

CO6: Gain knowledge about gastro-intestinal tract and associated disorders

CO7: Gains knowledge about structure/ function of kidney and associated disorders

CO8: Have basic understanding of the pathophysiology of addictions (alcohol, smoking, drugs)

CO9: Understand the socio-economic implications associated with alcohol and drug abuse

CO10: Understand the functioning of global (Government and NGOs) working against alcohol and drug abuse

**Unit 1 Modern lifestyles and habits (09)**

Modern lifestyles - Sedentary habits, Junk food, Polluted environment, Sleeping habits, Smoking, Alcoholism, Drugs, Stress.

**Unit 2 Food (09)**

Elementary knowledge of balanced food. Obesity, Acidity, Dieting, Anorexia, Food poisoning. Deficiency of nutrients- Vitamins, Minerals, Beverages- hot and cold.

**Unit 3 Cardiovascular complications (10)**

Elementary knowledge of cardiovascular system: Atherosclerosis, Ischemia, Myocardial infarction (Heart attack), Hypertension.

**Unit 4 Diseases of the Digestive system (10)**

Elementary knowledge of digestive system and liver- Hepatitis, Fatty liver, Cirrhosis, Gallstones. Stomach- Gastritis, Acidity, Ulcer, Amoebiasis, Constipation, Piles.

**Unit 5 Diseases of the Digestive system (10)**

Elementary knowledge of Respiratory system- Common cold, Asthma, Wheezing, Allergic sinusitis. Elementary knowledge of Excretory system, Hypertension, Uncontrolled Diabetes, Kidey Stones.

**Total : 48 hours**

### **Text Books**

1. Carl A. Burtis and Edward R. Ashwood . Tietz Textbook of Clinical Chemistry and Molecular Diagnostics, 5edition, 2012. Saunders Publication.
2. M N Chatterjee and Rana shinde. Textbook of Medical Biochemistry-,8<sup>th</sup> edition, 2011. Jaypee Publishers.

### **Reference Books**

1. Thomas M. Devlin. Biochemistry with Clinical Correlation, 7<sup>th</sup> edition, John Wiley & Sons. 2004.
2. Harold Varley, Practical Clinical Biochemistry, fourth edition, 2005. CBS Publisher
3. Dennis L. Kasper, Anthony S. Fauci, Stephen L. Hauser, Dan L. Longo. Harrison Principles of Internal Medicine- 19<sup>th</sup> edition, 2015

**Course objectives**

This paper provides a basic understanding of the nervous system, Structure and function relationship and integration of the nervous tissue networking and insights in to neurotransmission

**Course outcomes**

**After the completion of this course, the student will be able to**

CO1: Understand the physiology of human nervous system

CO2: Understand the anatomy of the central nervous system and its integration with the peripheral nervous system

CO3: Explain the anatomy and physiology of neurons

CO4: Gain knowledge on the structure and function of different types of cells of the nervous system

CO5: Understand neuronal signaling and synaptic transmission

CO6: Gain knowledge about different types of neurotransmitters and mechanism of action

CO7: Understand the mechanism involved in the sensory and motor function

CO8: Understand the mechanism involved in learning and memory formation

CO9: Gain knowledge on pathophysiology of different types of neurodegenerative disorders

CO10: Gain knowledge on the anatomy of blood brain barrier and its importance

**Unit 1 Neuron****(10)**

Neuron- Neurocellular anatomy, neural membrane, classification of neuron, nerve fibers, axonal transport, neural growth, neuroglia , nervous system, blood brain barrier, cerebrospinal fluid.

**Unit 2 Nerve potential****(09)**

Neuronal signaling -Membrane potentials, ion channels, recording neuronal signals, ionic basis of resting potential and action potential, propagation of action potential.

**Unit 3 Synapse****(09)**

Synaptic transmission- Synapse, Electrical synapse transmission, chemical synaptic transmission, Synaptic transmitter release, synaptic potentials, synaptic delay, synaptic plasticity, molecular mechanism of synaptic transmission, myoneural junction.

**Unit 4 Neurotransmitters****(10)**

Neurotransmitters- Chemistry, synthesis, storage, release, receptors and function- acetyl choline, catecholamines, serotonin, histamine, glutamate, asparatate, GABA, glycine, neuropeptides, nitric oxide.

**Unit 5 Neuro disorders****(10)**

Neural processing and neurodegenerative disorders-Learning and memory, neurochemical basis of drug abuse, neurodegenerative disorders, Parkinson's disorder, Alzheimer's disorder, Amyotrophic Lateral Sclerosis, Senile Dementia.

**Total : 48 hours**

**Text Books**

1. Arthur C. Guyton and John E Hall, Text book of medical physiology 11<sup>th</sup> Edition; 2006
2. David Nelson and Michael Cox, Lehninger Principles of Biochemistry, 4<sup>th</sup> edition; 2005

**Reference Books**

1. Bruce Alberts, Alexander Johnson, Juliana Lewis, Martin Raff, Keith Roberts and Peter Walter, Molecular biology of the cell, 4<sup>th</sup> Edition; 2004
2. Gordon Shepherd, Neurobiology, 3<sup>rd</sup> Edition; 1994
3. Mark F Bear, Barry W Connors and Michael A Paradiso, Neuroscience: Exploring the brain, 4<sup>th</sup> Edition; 2015

**Course objectives**

This paper ascertains that the biochemists get an accurate information about various hormones, functions, mechanism of action, and related disorders.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Understand the basic terminologies of hormones, classification of hormones based on its chemistry.
- CO2: Deduce the structure of amino acid derived, protein and steroid hormones.
- CO3: Understand the synthesis of various hormones by respective gland.
- CO4: Understand the regulation of hormones action by feedback mechanism.
- CO5: Understand the mechanism of action of steroid hormones,
- CO6: Understand the mechanism of action of pancreatic hormones,
- CO7: Understand the mechanism of action of thyroid hormones
- CO8: Understand the mechanism of action of sex hormones.
- CO9: Demonstrate various types of second messengers and their action.
- CO10: Learn various functions of thyroid, pancreatic and sex hormones.
- CO11: Demonstrate the dysfunction of various endocrine glands.

**Unit 1 Pituitary Hormones****(10)**

Hormones – Classification, biosynthesis, transport, modification and degradation. Structure of receptors, Feedback regulation. Mechanism of hormone action. Hypothalamic and pituitary hormones. Hypothalamic releasing factors. Hypothalamic hypophyseal portal system. Anterior pituitary hormones- GH, TSH, ACTH, LH, FSH and PRL biological role, feedback regulation and related disorders of hypo and hyper secretion.. Posterior pituitary hormones- oxytocin and vasopressin – biological actions, regulation and related disorders.

**Unit 2 Thyroid hormones****(09)**

Thyroid hormones – synthesis, secretion, regulation, transport, metabolic fate and biological actions. Antithyroid agents. Hyper and hypothyroidism. Hormonal regulation of calcium and

phosphate metabolism. Parathyroid hormones-Parathormone and Calcitonin -biological actions, and related disorders-. Hypercalcemia and hypocalcemia, Rickets and osteomalacia.

**Unit 3 Adrenal Hormones (10)**

Hormones of Adrenal cortex- Synthesis, action, biological role, regulation, transport and metabolism. Adrenal function tests. Disorders of adrenal cortex-Cushing's syndrome, aldosteronism, Congenital adrenal hyperplasia, Adrenal cortical insufficiency. Hormones of Adrenal medulla synthesis, biological role, metabolism, regulation and related disorder-Phaeochromocytoma.

**Unit 4 Pancreatic hormones (10)**

Pancreatic hormones – synthesis, regulation, biological effects and mechanism of action of glucagon, somatostatin and insulin. Insulin receptors. Related Disorders – Diabetes mellitus. Brief account of gastrointestinal Hormones.

**Unit 5 Gonadal hormones (09)**

Gonadal hormones - Biosynthesis, biological actions, transport, regulation and metabolism of androgens, oestrogen and progesterone., The menstrual cycle. Pregnancy –Biochemical changes and diagnostic tests. Gonadal Disorders.

**Total : 48 hours**

**Text Books**

1. Prakash.S.Lohar, Endocrinology, MJP Publishers, 2005
2. R.Radheshyam, Textbook of Endocrinology, Neha Publishers, 2012.

**Reference Books**

1. Hadley ME, The vertebrate endocrine system, in. Endocrinology, 4th Edition (Prentice Hall, NJ) 1996.
2. C. Guyton, MD and John E. Hall, Textbook of Medical Physiology, 11th Edition, 2006
3. Larsen: Williams Textbook of Endocrinology, 10<sup>th</sup> ed. , 2003 Elsevier
4. R.Radheshyam, Behavior endocrinology, Neha Publishers, 2013

**Course objectives**

This paper provides insights into the primary metabolic pathways occurring in plants, the types of plant metabolites and the industrial potential of those metabolites and the role of hormones in plant growth.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Develop a basic understanding of biochemical events associated with structural arrangement of plant cell and organization.
- CO 2: Explain and understand the biochemistry of photosynthetic process and its relation to man and its environment.
- CO3: Understand the mechanism of Nitrogen fixation and its importance in agricultural production and economics.
- CO4: Know the significance of plant growth regulators in the development of plants.
- CO5: Acquire knowledge about the importance of secondary metabolites and its industrial applications.
- CO6: Explain and understand the biochemistry of plant growth and development.
- CO7: Understand the role of biochemists in evaluating the potential industrial and medicinal applications of plants.
- CO8: Develop skills and knowledge to conduct basic research work in the field of Plant Biochemistry.
- CO9: Demonstrates ability to explain relation between Photosynthesis, growth hormones and Plant growth.
- CO10: Understands about the existence of naturally available and metabolically important growth regulators and secondary metabolites and its potential in crop development.

**Unit 1 Photosynthesis****(10)**

Ultra Structure and organization of chloroplast membranes, lipid composition of chloroplast membranes, electron transport chain. Thylakoid membrane protein complexes. Calvin cycle: Biochemistry of RuBp Carboxylase or oxygenase, Hatch and slack pathway, CAM plants; productivity of C<sub>4</sub> plants.

**Unit 2 Nitrogen Metabolism (09)**

Nitrogen fixation, nitrogenase complex, electron transport chain and mechanism of action of nitrogenase. Structure of 'NIF' genes and its regulation, Hydrogen uptake and bacterial hydrogenases, Nitrate Metabolism: Enzymes of nitrate metabolism, Ammonium assimilation enzymes: glutamine synthetase, glutamate synthase and GDH.

**Unit 3 Plant Hormones (09)**

Plant growth regulators: Auxins; gibberellins, cytokines, abscisic acid and ethylene - biosynthesis and their metabolic functions, synthetic growth hormones, inhibitors. Stress response in Plants.

**Unit 4 Secondary metabolites I (10)**

Major chemical classes of secondary metabolites: A brief account of the following classes: Alkaloids, terpenoids, flavonoids, Phenolics and phenolic acids, steroids, coumarins, quinines, acetylenes, cyanogenic glycosides, amines and nonprotein amino acids, gums, mucilages, resins etc. (Structures not necessary. Give examples of the compounds and the plants in which present and their importance).

**Unit 5 Secondary metabolites II (10)**

Importance of secondary metabolites: Uses of secondary metabolites to man: as drugs, precursors of drugs in pharmaceutical industry, as natural pesticides/insecticides; other uses of secondary metabolites.

**Total : 48 hours**

**Text Books**

1. H.D Kumar and H.N Singh. Plant Metabolism Publisher. Macmillan, ISBN-10: 0333256387: ISBN-13:978-0333256381. 1<sup>st</sup> Ed, 1980.
2. K.G Ramawat, Biotechnology: Secondary Metabolites Publisher: Science Publishers, U.S. ISBN-10: 1578080576 ISBN-13: 978-1578080571, 1<sup>st</sup> Ed., 2000.

**Reference Books**

1. P.M Dey and J.B. Harborne (Editors) Plant Biochemistry, Publisher: Academic Press ISBN-13:978-0122146749, 1<sup>st</sup> Ed, 1997.
2. Prof David T. Dennis, Prof David H. Turpin, Dr Daniel D. Lefebvre and Dr David B. Layzell (Ed) Plant Metabolism, publisher: Longman; ISBN-13:978-582259065, 1<sup>st</sup> Ed, 1997.
3. Hans-Walter Heldt Professor Em, Plant Biochemistry, publisher: Academic ISBN-10: 0120883910 ISBN-13: 978-0120883912, 3<sup>rd</sup> Ed, 2004.



**Course objectives**

This paper provides a complete understanding of the responses of the human body to toxic agents and the therapeutic approaches to toxicity. The paper also deals with the forensic aspects like legal procedures and types of trauma.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Understand the basic principles of and have current, cutting-edge knowledge in human health toxicology
- CO2: Describe toxicological mode of actions for most important groups of chemical substances to humans and environmental species.
- CO3: Define the most vulnerable target organ(s) or organism(s) for most important group of xenobiotics.
- CO4: Demonstrate knowledge on safety toxicology, and extrapolation from animal to human.
- CO5: Understand the use of physico-chemical parameters of compounds to predict toxicity, bioaccumulation and biomagnification
- CO6: Assess both acute and chronic toxicity data and evaluate different types of dose-response relationships including effects of mixtures of compounds with similar mode of action
- CO7: Quantify a dose or an exposure of a chemical and be able to predict the most important exposure routes to humans and environment and exposure due to occupation.
- CO8: Suggest how to diminish an exposure of chemical in both human, environmental and occupational toxicology (practical management)
- CO9: Classify chemicals and xenobiotics.
- CO10: Demonstrate the biochemical basis of toxicity

**Unit 1 Fundamentals of toxicology****(10)**

Fundamentals of Toxicology and dose-Response Relationships: Introduction Biomarkers Criteria of Toxicity New Technologies Evaluation of Toxicity Interactions; Dose Response; Measurement of Dose-Response; Relationships Linear Dose Response Hormesis; Hazard and Risk Assessment Duration and Frequency of Exposure and Effect

## **Unit 2 Toxic responses**

**(09)**

Factors Affecting Toxic Responses: Disposition : Absorption ,Sites of absorption, distribution, Excretion; Metabolism: types of Metabolic change phase I reactions; Phase 2 reactions; control of Metabolism, Toxication vs. Detoxication

## **Unit 3 Toxicity testing**

**(09)**

Test protocol, Genetic toxicity testing & Mutagenesis assay: *In vitro* test systems: bacterial mutation tests-Reversion test, Ames test, Fluctuation test, and Eukaryotic mutation test. *In vivo* test system Mammalian mutation test-Host mediated assay and Dominant Lethal test. Biochemical basis of toxicity: Mechanism of toxicity: Disturbance of excitable membrane function, Altered Calcium homeostasis, Covalent binding to cellular macromolecules&genotoxicity, Tissue specific toxicity

## **Unit 4 Xenobiotics**

**(10)**

Toxic Responses to Foreign Compounds: Direct Toxic Action: Tissue Lesions; Mechanism and response in cellular toxicity, pharmacological, physiological and Biochemical effects; Developmental Toxicology-Teratogenesis; Immunotoxicity Genetic Toxicity; Chemical Carcinogenesis

## **Unit 5 Mechanisms of toxicity**

**(10)**

Biochemical Mechanisms of Toxicity:Tissue Lesions: Liver Necrosis; kidney Damage; Lung Damage, Liver damage, Cardiac damage; Neurotoxicity; Exaggerated and Unwanted pharmacological effects; Physiological effects; Biochemical Effects: Lethal Synthesis and Incorporation, Interaction with specific Protein Receptors; Teratogenesis; Immunotoxicity; multi-Organ Toxicity:

**Total : 48 hours**

## **Text Books**

1. Narayanareddy K. S., The Essentials of Forensic Medicine & Toxicology, 2007. Published by K. Sugana Devi, 26<sup>th</sup> Edition, Hyderabad.
2. Basu, R. Fundamentals of forensic medicine and toxicology. 2009. 2nd Edition. Books and Allied(P) Ltd. Kolkata.
3. Apurba Nandy, Principles of Forensic Medicine,2005, Published by New Central Book Agency.
4. Guharaj P. V., Forensic Medicine, 2003, Orient Longman Limited, Hyderabad.

## Reference Books

1. Parikh C.K., Parikh's Textbook of Medical Jurisprudence and Toxicology, Publishers, Bangalore.6<sup>th</sup> Edition 1999,Reprint 2007.
2. Franklin, C.A Modi's medical Jurisprudence and Toxicology, published by M. Tripathi Private Limited,.21<sup>st</sup> Edition. Bombay.
3. Keith Simpson, Bernard Knight, 1988, Forensic Medicine, ELBS. 9<sup>th</sup> Edition
4. Pillay V.V., Text book of Forensic Medicine,2009, Paras Publication. Hyderabad
5. JB Mukherjee's Forensic Medicine and Toxicology – Volume I and II (combined)-edited by Karmakar ,III Edition 2007.
6. Lyon's Medical Jurisprudence & Toxicology ,2004, 11<sup>th</sup> Edition : Delhi Law House, Delhi
7. Modi's Textbook of Medical Jurisprudence and toxicology- Edited by BV Subramanyam, Butterworths India, New Delhi.22nd edition, 2001.
8. Dr. Krishan Vij- Text book of Forensic Medicine & Toxicology- Principles and Practice, BI Churchill Livingstone, New Delhi, 2nd edition, 2002.

**Course objectives**

The course integrates the descriptive, experimental and biochemical approaches into a conceptual framework for the analysis of development. The course deals with key steps in the transformation of the single-celled zygote into the complex, multicellular, adult organisms and links genetics with embryology.

**Course outcomes**

**After the completion of this course, the student will be able to**

CO1: Know about the basic concepts of developmental biology

CO2: Know how fertilization and cleavage occur

CO3: Discern out the process and consequence of gastrulation

CO4: Know about the process of differentiation to many different types of cells and tissues

CO5: Have understanding of the basic concepts of organogenesis

CO6: Have understanding of the basic concepts of Morphogenesis

CO7: Have understanding of the basic concepts of regeneration

CO8: Have understanding of the basic concepts of aging

CO9: Have knowledge about gene expression and regulation

CO10: Have fundamental knowledge of animal embryonic development--that is how an egg develops into an adult.

**Unit 1 Evolution and Fertilization****(10)**

Introduction, history and evolution – an overview. Development among unicellular eukaryotes *Acetabularis*, *Naegleria*. The origins of sexual reproduction.

Fertilization: structure of gametes, recognition of sperm and egg –action at distance and contact of gametes. Cleavage: Patterns of embryonic cleavage, radial holoblastic cleavage, spiral holoblastic cleavage, mechanisms of cleavage –regulation of cleavage cycles.

**Unit 2 Model organisms****(09)**

Major model organisms. Availability/ culture and cost; access and micro-manipulation. Examples: *Drosophila*, zebrafish, *Caenorhabditis elegans*, chicks

**Unit 3 Embryonic development in animals (10)**

Early Embryonic Development, morphogenesis and organogenesis in animals: Blastula formation, Types of Cleavage, Gastrulation and formation of germ layers in animals.

Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*, organogenesis –vulva formation in *Caenorhabditis elegans*; eye lens induction, limb development in vertebrates, neuron differentiation, larval formation, metamorphosis; environmental regulation of normal development.

**Unit 4 Early Embryonic Development in plants (09)**

Early Embryonic Development in plants: Gametogenesis, Fertilization, Embryo sac development and double fertilization in plants

**Unit 5 Regeneration and Apoptosis (10)**

Cell death and regeneration. Concept of regeneration; cell cycle, programmed cell death; aging and senescence. Basics of cancer development.

**Total : 48 hours**

**Text Books**

1. T. Subramoniam, Molecular developmental biology. 2nd Edition, 2011.
2. Manju Yadav, Molecular Developmental Biology. Discovery Publishing Pvt.Ltd. 2008.
3. Abhilash jain, Advanced developmental biology. 2010.

**Reference Books**

1. Scott F. Gilbert, Susan Singer, Developmental Biology. Sinauer Associates Inc.; 8<sup>th</sup> ed, 2006.
2. Jonathan M. W. Slack, Essential Developmental Biology. Wiley-Blackwell. 3rd Edition, 2012.
3. Fred Wilt and Sarah Hake, Principles of Developmental Biology. First edition, 2003.
4. R.M. Twyman, Developmental Biology. First edition, 2001.
5. Lewis Wolpert, Developmental Biology: A Very Short Introduction. Oxford University Press; 1st edition, 2011.

**Course objectives**

To make students to understand the basics of nano, nanoparticles, nanomaterials, various methods of synthesis of nanoparticles, applications of nanoparticles, Synthesis and characterization of new nanoparticles.

**Course outcomes**

**After the completion of this course, the student will be able to**

CO1: Acquire knowledge about basics of nano scale, nano particles and nanomaterials

CO2: Gain expertise in designing experiments and research hypothesis

CO3: Understand the principle and industrial application of nanoparticle

CO4: Understand the mechanism for synthesis of nanoparticles

CO5: Know the principle and operating systems of bio analytical instruments

CO6: Synthesise nanomaterials

CO7: Understand the types of nanoparticles

CO8: Understand the characterization of nanomaterials by using bio analytical instruments

CO9: Demonstrate the physical and chemical properties of nanoparticles

CO10: Demonstrate the application of nanoparticles in medical field

**Unit 1 Introduction****(10)**

Background to Nanotechnology: Scientific revolution- Atomic structures-Molecular and atomic size-Bohr radius – Emergence of Nanotechnology – Challenges in Nanotechnology - Carbon age–New form of carbon (from Graphene sheet to CNT).

**Unit 2 Nanostructures and nanomaterials****(10)**

Definition of a Nano system - Types of Nanocrystals-One Dimensional (1D)-Two Dimensional (2D) -Three Dimensional (3D) nanostructured materials. Carbon Nanotubes (CNT) - Metals (Au, Ag) - Metal oxides (TiO<sub>2</sub>, CeO<sub>2</sub>, ZnO), Biological system - DNA and RNA - Lipids – Size dependent properties - Mechanical, Physical and Chemical properties.

**Unit 3 Synthesis of nanomaterials****(9)**

Synthesis of bulk nanostructured materials - Sol Gel processing- Mechanical alloying and milling-inert gas condensation technique-bulk and nano composite materials - Grinding - high energy ball milling-types of balls-WC and ZrO<sub>2</sub>-materials –ball ratio-limitations- melt quenching and annealing

**Unit 4 Characterization of nanomaterials (10)**

Characterisation: Spectroscopic techniques - Infra red spectroscopy (IR)- UV-visible-Absorption, Imaging techniques - Diffraction analysis – XRD, Imaging techniques – Scanning Electron Microscope, Transmission Electron Microscope.

**Unit 5 Nanomedicine (10)**

Nanotechnology for drug discovery - protein and peptide based compounds for cancer and diabetes - drug delivery - nanoparticle based drug delivery - lipid nanoparticles - vaccination - cell therapy -Gene therapy.

**Total : 48 hours**

**TextBooks**

1. S.Shanmugam, Nanotechnology, MJP Publishers, 2010
2. Edited by Jurgen Schulte, Nanotechnology, John Wiley & Sons Ltd., 2010

**Reference Books**

1. Charles.P.Poole.Jr., Frank.J.Owens, Introduction to Nanotechnology, John Wiley & Sons, Inc., 2009
2. Richard.E.Smalley, Nanotechnology,Jaico publishing house, 2011
3. Richard Booker, Earl Boysen, Nanotechnology, Wiley publishing Inc., 2010
4. Nanosystems, K.Eric Drexler, John Wiley & sons Inc., 2010
5. R.Balasubramaniam, Callister's material science and engineering, Wiley India, 2011

**Course objectives**

This paper aims to provide thorough information on the basic properties of stem cells and the regulation at molecular level. It also describes the application of stem cell technology in the therapy of different diseases.

**Course outcomes**

**After the completion of this course, the student will be able to**

- CO1: Know about various stem cells, their characteristics and their niches
- CO2: Understand the importance of growth factors
- CO3: Understand the basis of media composition for growth of stem cells
- CO4: Discern the molecular concepts of stem cell self-renewal and tissue and organ development.
- CO5: Demonstrate the routine methods used in stem cell biology.
- CO6: Know the different types of stem cells, how they are derived and the extent of their plasticity.
- CO7: Know how tumor stem cells give rise to metastases and treatment-resistant remnant cells that cause relapse, and how this impacts on the development of future cancer treatment strategies
- CO8: Demonstrate how epigenetic mechanisms encompassing various DNA modifications and histone dynamics that are involved in regulating the potentiality and differentiation of stem cells
- CO9: How microRNAs are involved in regulating stem cell differentiation
- CO10: Discern out the application of stem cell in therapies

**Unit 1 Stem cells****(09)**

Definition, characterization, pluripotency, niche specification – Drosophila germ line stem cells, self renewal and differentiation.

Adult versus embryonic stem cells, post genomic adult stem cells, stemness, characteristics, hierarchy, stem cell niche. Adult stem cell from amniotic fluid, cord blood.

Isolation and maintenance of murine stem cells, primate embryonic stem cells, human embryonic



stem cells.

**Unit 2 Embryonic stem cells (10)**

Principle of cell passage, colony formation, techniques for derivation of embryonic stem cells, differentiation and transdifferentiation.

Derivation and maintenance of human embryonic stem cells, derivation and differentiation of human embryonic germ cells, isolation and maintenance of avian embryonic stem cells, Xenopus embryonic stem cells, zebrafish embryonic stem cells.

**Unit 3 Culture (10)**

Trophoblast stem cells – Identification and lineage specificity, isolation and maintenance of neural precursors, primitive hematopoietic cells. GF and serum free culture of stem cells, feeder free culture, genetic manipulation of human embryonic stem cells, gene silencing, RNAi, vector modified transformation on lentivirus. Recombination, homologous recombination.

**Unit 4 Properties (10)**

Surface antigen markers, lineage markers, microarray, chemical mutagenesis. Hitchhiker effect, gene silencing, epigenetic mechanism, nuclear transfer cloning, parthenogenetic stem cells.

**Unit 5 Applications (10)**

Pluripotency of neural and cloned mouse embryo, genomic reprogramming, immunogenicity of stem cells, tolerance in transplantation. Therapeutic application- neurodegenerative disorders, spinal cord injury, heart diseases, diabetes, tissue engineering.

**Total : 48 hours**

**Text Books**

1. Kiessling, A.A. Human Embryonic Stem cells. Jones & Barlett Publishers. 2<sup>nd</sup> Ed, 2006.
2. Lanza, R . Essentials of Stem Cell Biology. Academic Press. 1<sup>st</sup> Ed, 2005

**References Books**

1. Turksen, K. Adult Stem Cells. Humana Press, Inc. 1<sup>st</sup> Ed, 2004
2. Thomson, J et al. Handbook of Stem Cells: Embryonic/ Adult and Fetal Stem cells (Vol. 1 & 2). Academic Press , 1<sup>st</sup> Ed, 2004.
3. Institute of Medicine (Corporate author). Stem cells and the future of regenerative medicine. National Academy Press., 1<sup>st</sup> Ed, 2002.

**Course objectives**

This curriculum is designed to provide students a broad understanding of the molecular, genetic, cell biological, and pathobiological aspects of cancer. Students will also learn about the current state of clinical diagnosis, treatment of human cancers, and hurdles to overcome to realize its potential.

**Course outcomes**

**After the completion of this course, the student will be able to**

CO1: Have better understanding of terminologies of ‘Molecular Biology’

CO2: Have basic understanding of ‘Genetics’

CO3: Gain knowledge on cell cycle as well as apoptosis

CO4: Have knowledge about cancer, its development and types

CO5: Have knowledge about genes with reference to cancer formation and mechanism

CO6: Have basic understanding of carcinogens and carcinogenesis

CO7: Have elementary knowledge about tumor markers

CO8: Know about the role of tumor suppressor genes

CO9: Understand the signaling of cancerous cells

CO10: Have basic understanding of diagnostic tools for cancer and therapies available

**Unit 1 Cell cycle****(10)**

Regulation of Cell cycle - Cell cycle control and pRb tumor suppressor. Apoptosis and p53 tumor suppressor. Mutations that cause changes in signal molecules - effects on receptor - signal switches. Tumor suppressor genes. Modulation of cell cycle in cancer. Different forms of cancers. Diet and cancer.

**Unit 2 Carcinogenesis****(09)**

Chemical Carcinogenesis, Metabolism of Carcinogens, Natural History of Carcinogenesis, Targets of Chemical Carcinogenesis, Principles of Physical Carcinogenesis, X-Ray radiation – Mechanism of radiation Carcinogenesis. DNA repair mechanisms.

**Unit 3 Oncogenes****(10)**

Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes Oncogenes / Proto Oncogenes activity RAS, NFkB, Wnt signaling in cancer. Epigenetics of cancer – DNA methylation, Histone modification, gene silencing by micro RNA.

**Unit 4 Metastasis****(10)**

Clinical significances of invasion, Metastatic cascade Three step theory of invasion, Proteinases and tumour cell invasion. Multi-step tumorigenesis and the evolution of cancer. Tumor-promoting stimuli. Cancer stem cells.

**Unit 5 Treatment****(09)**

Different forms of therapy - Chemotherapy, Radiation Therapy, Immunotherapy. Detection of Cancers. Prediction of aggressiveness of Cancer. Advances in Cancer detection

**Total : 48 hours****Text books**

1. Vincent.T, Devita, Cancer-Principles & practice of oncology, 3<sup>rd</sup> edition, 2014.
2. Momna Hejmadi, Introduction to Cancer Biology. 2<sup>nd</sup> edition.

**Reference Books**

1. Kinnell Parchment G. Mc. R. E, Perantoni. The Biological Basis of Cancer, Cambridge University Press, 2<sup>nd</sup> Edition, , 2006
2. Robert A. Weinberg, The Biology of Cancer. Garland Science. 2006.
3. Lauren Pecorino, Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics Oxford University Press; 3 edition, 2012.
4. Raymond W. Ruddon, Cancer Biology. Oxford University Press, 2007.

**Course objectives**

The course was designed in such a way to impart knowledge of signaling mechanisms taking place at cellular level and to assess the mechanism of signaling molecules in transduction process

**Course outcomes**

CO1: Understand the basics of “Cell Biology”

CO2: Comprehend the historical and current understanding of cell membrane structure and function

CO3: Demonstrate membrane structure and functions

CO4: Demonstrate the types of transport mechanisms on membranes

CO5: Encompass the basic concepts of co-ordination and integration in multicellular organisms with respect to metabolic events

CO6: Encompass the fundamentals of ligand and receptor interactions

CO7: Understand the basics and different types of signaling pathways

CO8: Gain knowledge on signal transduction and

CO9: Gain knowledge on the role of second messengers

CO10: Understand Basics of cell cycle as well as apoptosis

CO11: Know about cancer, its development and types

**Unit 1 Membrane Transport****(10)**

Membrane assembly – importins and exportins. Membrane transport: Diffusion (passive and facilitated). Active transport – symport, antiport, Na<sup>+</sup> K<sup>+</sup> ATPase. Ion gradients, ion selective channels, group translocations. Endocytosis and exocytosis.

**Unit 2 Cell Signaling I****(10)**

Fundamental concepts and definitions of signal, ligands, and receptors, Endocrine, paracrine and autocrine signaling. Receptors and signaling pathways – cell surface receptors, ion channels, G – protein coupled receptors, receptor kinases (tyr, ser/thr).

**Unit 3 Cell Signaling II****(09)**

Signal transduction through cytoplasmic and nuclear receptors. The Ras – raf – MAP kinase cascade. Second messengers – cyclic nucleotides, lipids and calcium ions. Crosstalk in signaling pathways.

**Unit 4 Cell cycle****(09)**

Cell Cycle: - Overview of cell cycle. Cell cycle Control in mammalian cells, Checkpoints in cell -cycle regulation.

**Unit 5 Cancer (10)**

Cell cycle and cancer: - Apoptosis (Programmed cell death) -- Pathways, regulators & effectors in apoptosis. Cancer: Properties of tumor cells & Genetic basis and onset of cancer. Tumor suppressor genes and functions of their products. Carcinogenic effect of chemicals and radiation. Molecular diagnosis of cancer.

**Total : 48 hours**

**Text Book**

1. Lodish et al. Molecular Cell Biology. Scientific 5th ed. Freeman.2003

**Reference Books**

1. De Robertis and De Robertis. Cell and Molecular Biology, Lea and Febiger. 8th ed. 2006
- 2.Karp G. Cell and Molecular Biology. 3rd ed. John Wiley and Sons. 2002.
- 3.Lodish et al. Molecular Cell Biology. Scientific 5th ed. Freeman.2003
4. Twyman. Advanced Molecular Biology. Viva books. 2nd ed. 1998
5. 6. Alberts et al. Molecular Biology of the Cell. 4th ed. Garland Sci. 2002.
7. Murray et al. Harper's Biochemistry. 26th ed. McGraw Hill. 2003 (for Unit-II).

**Course objectives**

The core Module Syllabus for Environment Studies includes class room teaching and Field Work. The course structure includes the continuing problems of pollution, loss of forest, solid waste disposal, degradation of environment, issues like economic productivity and national security, Global warming, the depletion of ozone layer and loss of biodiversity have made everyone aware of environmental issues.

**Course outcomes**

**After the completion of this course, the student will be able to**

CO1: Understand complex relationships between natural and human system

CO2: Demonstrate awareness of ecosystem

CO3: Understand the ecological knowledge and its consequences

CO4: Easily assess the environmental changes and challenges

CO5: Understand natural science, how biology, chemistry and physics interlinked

CO6: Understand the importance of natural and artificial resources

CO7: Understand and implement the sustainable use of resources

CO8: Have the ability to collect and interpret the scientific data

CO9: Design and execute a scientific projects

CO10: Describe and analyse the current global environmental problems

**Unit 1 Principles and Concepts of ecosystem****(10)**

Structure of ecosystem and Homeostasis- Energy transfer in an ecosystem-Food chain. Food web-Ecological efficiencies- Trophic structure and energy pyramids. Biogeochemical cycles(N, C, P cycles). Biodiversity: Types of diversity; Genetic diversity,Species diversity and Ecosystem diversity. Molecular taxonomy –Methods of biodiversity conservation- Gene banks; Cryopreservation. Assessing, analyzing and documenting biodiversity – Vulnerability and extinction of biodiversity.

**Unit 2 Properties of water****(10)**

Water quality parameters- pH, Dissolved Oxygen (DO), Chemical Oxygen demand (COD); Biological Oxygen demand(BOD); Atmospheric toxicants- CO, NO<sub>2</sub>, CO<sub>2</sub>, SO<sub>2</sub>-; Toxic heavy metals. Radionuclides. Sampling of air , soil and water pollutants - Monitoring techniques and methodology; Pesticide residue – classification, degradation, analysis, pollution due to pesticides; phenols and petrochemicals

**Unit 3 Traditional Biological treatment (10)**

stabilization pond, aerated lagoon, activated sludge process trickling filter anaerobic treatment. Use of microbes (bacteria and fungi) in biodegradation and Biotransformation: Bioremediation. Microbial transformation; Accumulation and concentration of metals; Biosorption- Oil field microbiology; Improved oil recovery; Biotechnology and oil spills.

**Unit 4 Environmental Biotechnology (10)**

Biodegradation of agricultural chemicals; GM Crops and their impact on environment; Biofertilizers; Biological control of insect pests; Role of biopesticides/ insecticides; Biocontrol of plant pathogens; Integrated pest management-practical implementation

**Unit 5 Role of biotechnology in management of resources (09)**

Reclamation of wasteland: Biomass production: Biogas and biofuel production; Development of environment-friendly processes such as integrated waste management. Nature of Environmental Policies; International Agreements and Treaties:Stockholm Conference (1972); Rio Conference (UNCED) (1992); Johnesburg treaty; GAAT and Environment; CITES; Montreal protocol National Policy on Environment, Constitutional provisions for Environmental Protection.

**Total : 48 hours**

**Text Books**

1. Trivedi R.K., Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vol I and II, Enviro Media (R). 2006
2. Agarwal, K.C. Environmental Biology, Nidi Publ. Ltd. Bikaner. 2001

**Reference Books**

1. Sharma B.K. Environmental Chemistry. Geol Publ. House, Meerut. 2001
2. Jadhav, H & Bhosale, V.M. Environmental Protection and Laws. Himalaya Pub. House, Delhi 1995.

## **GENERIC ELECTIVES**



**Course objectives**

To enable the students to develop their communication skills effectively. To make students familiarize with the English Language, to enrich vocabulary in English and to develop communicative competency

**Unit 1 Reading Comprehension and Vocabulary (5)**

Filling in the blanks – Cloze exercises – Vocabulary building- Reading and answering questions

**Unit 2 Listening and answering questions (5)**

Listening and writing – listening and sequencing sentences – filling in the blanks – Listening and answering questions

**Unit 3 Group Discussion (5)**

Why GD is a part of a selection process – structure of a GD - Strategies in GD – Team work – body language

**Unit 4 Conversations (5)**

Face to face Conversations & Telephone Conversations.

**5 Unit 5 Self-Introduction and Role Play (4)**

**Total : 24 hours**

**Text Books**

1. Robert Heller, Communicate Clearly – Dorling Kindersley Ltd., London 1998.

**Reference Books**

1. Matthukutty M. Monippally, Business Communication Strategies, Tata McGrawHill, 2001.
2. T.M. Farhatullah, Communication Skills for Technical Students, Orient Longman, 2002
3. Deborah Dumame Write to the top – Writing for Corporate Success; Random House, 2004
4. Jayashree Balan, Spoken English, Vijay Nicole Imprints , 2005.

## COMMUNICATIVE ENGLISH II

2002

### Course objectives

To enable the students to develop their communication skills effectively. To make students familiarize with the English Language, to enrich vocabulary in English and to develop communicative competency

**Unit 1 Presentation skills (5)**

**Unit 2 Soft Skills (5)**

Time Management, Stress Management and Body Language

**Unit 3 Resume/Report/Letter Writing (5)**

**Unit 4 30 Frequently asked Questions (5)**

**Unit 5 Interview Skills (4)**

**Total : 24 hours**

### Text Books

1. Robert Heller, , Communicate Clearly – Dorling Kindersley Ltd., London 1998.

### Reference Books

1. Matthukutty M. Monippnally, Business Communication Strategies, Tata McGrawHill, 2001.
2. T.M. Farhatullah, Communication Skills for Technical Students, Orient Longman, 2002
3. Deborah Dumame Write to the top – Writing for Corporate Success; Random House, 2004
4. Jayashree Balan, Spoken English, Vijay Nicole Imprints , 2005.

**Course objectives**

The course aims to provide students with a practical and hands-on experience with common bioinformatics tools and databases.

**Course outcomes****After the completion of this course, the student will be able to**

CO1: Demonstrate practical skills and gains hands on experience in common bioinformatics tools and databases.

CO2: Attain knowledge to interpret the relation among living things and solve biological problems, from the molecular to ecology level using bioinformatics tools.

CO3: Learn the physical, chemical and biological properties of Nucleic acids and proteins as a prerequisite for gene sequencing analysis.

CO4: Learn about primary and secondary databases of nucleic acids and proteins(Swissport, PIR, FASTA, Pubmed, Medline & NCBI).

CO5: Understand the basic concepts of Computer organization, functioning, data storage devices(Primary & Secondary).

CO6: Understand the integration of Biologicalsciences and statistics with Bioinformatics.

CO7: Demonstrates practical skills in retrieval of DNA sequences from Entrez databases, Retrieval of protein sequences.

CO8: Exhibits skill to create computer programmes that facilitates to conduct basic bioinformatics research.

CO9: Demonstrates skill to explain and apply the most appropriate dynamic programming for alignments of different biosequences.

CO10: Develops the skill in analysing and predicting secondary structure elements and in modeling of protein structures from the sequences provided.

**Unit I DNA and Proteins****(5)**

Nucleic acids: double helix, melting temperatures, closed circular DNA and supercoiling, Open Reading Frames (ORFs), Introduction to Proteins, Protein Structure: Secondary, Tertiary, Quarternary. The notion of Homology as evolutionary relatedness. Similarity and Identity of sequences..

## **Unit 2 Sequence databases and formats**

**(5)**

Primary and secondary databases. Nucleotide sequence databases, nucleotide sequence flat files. Functional divisions in sequence databases. Protein sequence databases: Genpept, Uniprot, Swissprot, PIR.

Genbank, FASTA, ASN. Information retrieval for biological databases. The NCBI resource. Entrez, Pubmed, Medline. Entrez Boolean search terms and statements. Locuslink, NCBI bookshelf

## **Unit 3 General introduction to computers**

**(5)**

Organization of computers, computer algorithms. Various devices, memory and application. Computers as a system : Basic concepts, stored programs, functional units, and their interrelation: communications with computer.

Data storage devices primary storage: storage addressed and capacity, types of Memory: Secondary storage devices : Magnetic tape – data representation and R/W: Magnetic disks, fixed and removable, data representation and R/W : Hard disks, Optical disks, CD-ROM, Mass storage devices.

## **Unit 4 Role of statistics in bioinformatics**

**(5)**

Fundamentals of statistics: Data types, collection and representation of data. Mean, median, mode, measures of dispersion. Probability definition, addition and multiplication theorems, Baye's Theorem.

## **Unit 5 Practicals**

**(4)**

1. Retrieval of DNA sequences from Entrez databases
2. Retrieval of protein sequences
3. Retrieval of sequences in different sequence formats
4. Searching for publications in Pubmed by different criteria

**Total : 24 hours**

## **Text Books**

1. Arthur lesk. Introduction to bioinformatics. 4<sup>th</sup> edition. 2014. Oxford University press.
2. Jin Xiong. Essential Bioinformatics: 2006. Cambridge University Press.
3. Mount David. Bioinformatics: sequence and genome analysis, 2<sup>nd</sup> edition. 2000, Cold Spring harbor Laboratory.

## **Reference Books**

1. Stephen Misener, Stephen A. Krawetz. Methods and Protocols (Methods in Molecular Biology) 1999, Humana Press.
2. Jonathan Pevsner. Bioinformatics and Functional Genomics 2nd Edition 2009, Wiley Blackwell.

**Course objectives**

The syllabi of Pathology compliments and supplements the necessary knowledge students have gained in Physiology. Consequently it incorporates topics like cellular adaptations, inflammation, neoplasia, cellular ageing and other infectious diseases. Pathology also provides the necessary inputs for the other disciplines like Pharmacology, social and preventive medicine, medicinal biochemistry etc.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Attain a thorough knowledge on the cellular adaptations and the response of tissues to neoplasia.
- CO2: Understand the pathological changes during cellular ageing and other infectious diseases.
- CO3: Provide An insight into the history of pathology covering all the basic definitions and common terms.
- CO4: detail on the survival mechanism in diseases, an insight into microscopic and cellular pathology.
- CO5: Elaborate the overview of cellular adaptation including Hyperplasia, Hypertrophy, Atrophy, and Metaplasia.
- CO6: assess the causes and mechanisms of cell injury- reversible and irreversible injury, and also on Necrosis and Apoptosis.
- CO7: Understand the basic concepts related to acute and chronic inflammation.
- CO8: Discuss on the vascular changes and cellular events that happen during inflammation.
- CO9: Study the morphological effects of an inflammation response.
- CO10: Understand the basic mechanism of tissue regeneration, and repair by healing, scar formation and fibrosis.
- CO11: Detail on Edema, hyperemia, congestion, hemorrhage, hemostasis and thrombosis, Embolism, Infarction and shock with suitable examples.

**Unit 1 Introduction (5)**

History of pathology, Basic definitions and common terms used in pathology, Survival mechanism and disease, microscopic and cellular pathology, scope and techniques used.

**Unit 2 Cell Injury and responses of cells: Cellular Adaptations, and Cell Death (5)**

An overview of cellular adaptation: Hyperplasia, Hypertrophy, Atrophy, Metaplasia; Causes and mechanisms of cell injury, reversible and irreversible injury, Necrosis, Apoptosis, Types of apoptosis, Intracellular accumulations, Cellular ageing

**Unit 3 Role of Inflammation in disease (5)**

Basic concepts with suitable examples of general features of acute and chronic inflammation: Vascular Changes, cellular events, important chemical mediators of inflammation, Morphological effects inflammation response, Granulomatus Inflammation.

**Unit 4 Role of Tissue repair Healing and Fibrosis (4)**

Basic mechanism of tissue regeneration, and repair by healing, scar formation and fibrosis

**Unit 5 Common Hemodynamic Disorders in diseases (5)**

An overview of Edema, hyperemia, congestion, hemorrhage, hemostasis and thrombosis, Embolism, Infarction and shock with suitable examples

**Total : 24 hours**

**Text Books**

1. Robbins and Cotran. Pathologic Basis of Disease, 8th edition (2009), Vinay Kumar, Abul. K. Abbas, Jon C. Aster, Nelson Fausto; Saunders Publishers, ISBN-13: 978-1416031215

**Reference Books**

1. J.,Ed. Underwood and J. C. E. Underwood General And Systematic Pathology, 2nd edition (1996); Churchill Livingstone, ISBN-13: 978-0443052828
2. Ramnik. Sood Medical Laboratory Technology Methods and Interpretations, 6th edition (2009),; Jaypee Brothers Medical Publishers, ISBN-13: 978-8184484496.

**Course objectives**

The kinds of alternative medicines and the importance of medicinal plants has been well described in this paper.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Understand the basic terminologies and scope of indigenous system of medicine
- CO2: Discuss about the preparation and application of plant based drugs.
- CO3: Demonstrate the preparation and applications of Ayurveda, Siddha, Unani medicines.
- CO4: Explore knowledge on different methods of plant conservation and propagation.
- CO5: Know about definition and applications of ethnobotany in India.
- CO6: Explore knowledge on applications of natural products in clinical disorders.
- CO7: Learn about the Conservation of endangered and endemic medicinal plant
- CO8: Learn about the components and maintenance of nursery
- CO9: Learn about the different methods of propagation for raising medicinal plants
- CO10: Attain knowledge on advantages of Ayurveda, Siddha and Unani system of medicine.

**Unit 1: Indigenous medicinal sciences I (5)**

Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments,

**Unit 2: Indigenous medicinal sciences II (5)**

Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations.

**Unit 3: Conservation of endangered and endemic medicinal plant (5)**

Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant. Gardens.

**Unit 4: Propagation of Medicinal Plants (4)**

Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

**Unit 5: Ethnobotany and Folk medicines****(5)**

Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany. Folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, blood pressure and skin diseases.

**Total : 24 hours****Text Book**

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.

**Reference Book**

1. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edition. Agrobios, India.



**Course objectives**

Biomaterials restore the body of a person back to normalcy following any trauma or disease. The paper comprises of topics which describes the properties, synthesis and application of biomaterials.

**Course outcomes****After the completion of this course, the student will be able to**

- CO1: Discuss fundamentals of biomaterials with emphasis on classification, chemistry and characteristics
- CO2: Elaborate the methods of synthesis of biomaterials
- CO3: Identify biomaterials appropriate for given application
- CO4: Study the advantages and disadvantages of different biomaterials
- CO5: Analyze biocompatibility and tissue-material interaction for different kinds of biomaterials
- CO6: Evaluate the different procedures used to test biocompatibility
- CO7: Analyze the modern techniques used to modify and characterize biomaterial
- CO8: Discuss on the importance of modified biomaterials
- CO9: Assess applications of biomaterials in tissue engineering, modulation of immune system, neuroengineering, diagnostics and bioanalytical techniques
- CO10: Design tissue engineering scaffolds for regenerative medicine and discuss ethical issues for tissue engineering & regenerative medicine.

**Unit 1: Introduction to biomaterials****(5)**

Classification, Chemistry and characterization of biomaterials. The state of the art of biomaterials and the challenges. Disciplines involved in biomaterials science and the path from a need to a manufactured medical device. Material selection requirements for biomaterials – metals, composites, ceramics and polymers. Tissue environment of the implanted biomaterial: unit cell processes. Tissue responses to implants. Nanomaterials: fullerenes, carbon nanotubes, nanomembranes. Synthesis of bio-materials, Characterization of chemical, physical, mechanical properties, visco elasticity, end group analysis, determination of molecular weight of a polymer.

**Unit 2: Biocompatibility****(5)**

Biocompatibility of Bio-materials, wound-healing process, body response to implants, blood compatibility. Tests to assess biocompatibility of a polymer, modifications to improve biocompatibility. Reactions of biomaterials with cellular and extra cellular components.

**Unit 3: Modified biomaterials (4)**

Biodegradative biomaterials, Bioactive polymers and biosynthetic polymers, inert biomaterials, genetically engineered biomaterials

**Unit 4 : Applications of Biomaterials – 1 (5)**

Tissue Replacement Implants, Acute Wound Healing, Blood Clotting, Chronic Wound Healing and Foreign Body Response. Soft-tissue replacements, sutures, surgical tapes, adhesive, percutaneous and skin implants, maxillofacial augmentation, blood interfacing implants, hard tissue replacement implants, internal Fractures fixation devices, joint replacements.

**Unit 5: Applications of Biomaterials - 2 (5)**

Artificial Organs Artificial Heart, Prosthetic cardiac Valves, Limb prosthesis, Externally Powered limb, prosthesis, Dental Implants, Other applications. Liposomes, hydrogels and Nanomaterials in drug delivery. Biomaterials in diagnostics and bioanalytical techniques.

**Total : 24 hours**

**Text Book**

1. Sujata V. Bhat, Biomaterials , 2 nd edition, Narosa Publishing House, New Delhi, 2006.

**Reference Books**

1. Buddy D. Ratner, B. D. Ratner, Allan S. Hoffman, Biomaterials Science: An Introduction To Materials In Medicine, 2nd Edition(2004) Publisher: Academic Press.  
2. Fred W. Billmeyer, Text book of Polymer Science. 3 rd edition John Wiley and sons publications.